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UNITED STATES NAVAL INSTITUTE PROCEEDINGS

Vol. 53 JULY, 1927 No. 293

Contents

Reflections on the Airship Situation.—Rosendahl - - - - 745
Interrelations of Sea and Air Problems.—Warner - - - - 759
Flight Training of Student Naval Aviators.—Studley - - - 764
After Jutland.—Gibson - - - - - - - - - - 774
Hydrographic Surveying with Aircraft.—Ramsey - - - - 777
Airplane Racing and Record Chasing.—Wead - - - - 782
Air Operations in Palestine.—Sherman - - - - - - 787
Air Mapping in Haiti.—Boyden - - - - - - - - 793
Discussion - - - - - - - - - - - - 797
Professional Notes - - - - - - - - - - 801
Notes on International Affairs - - - - - - - 814
Book Reviews - - - - - - - - - - - - 820
Secretary's Notes - - - - - - - - - - - 824

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100 Kilometers

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SPEED
500 Kilometers

Lieut. James D. Barner, U.S.N.

SPEED
1000 Kilometers

Lieut. Rutledge Irvine, U.S.N.

A STANDARD Vought "Corsair" Naval Seaplane, on April 14, 1927, reached a record altitude of 22,178 feet, carrying a ballast load of 1102 lbs., included in the total useful load of 1640 lbs. Lieut. George R. Henderson, U.S.N., Pilot.

THE SAME SEAPLANE, on April 25, 1927, with the same ballast load included in the 1675 lbs. useful load, averaged 147.263 miles per hour for 100 kilometers around a 25 kilometer closed course. Lieut. Steven W. Callaway, U.S.N., Pilot.

ON APRIL 30, 1927, the same "Corsair" Seaplane, flying around the same short 25 kilometer course, averaged 136.023 miles per hour for 500 kilometers, carrying 1880 lbs. useful load including 1102 lbs. ballast. Lieut. James D. Barner, U.S.N., Pilot.

AND STILL a fourth World's Record was made by the same "Corsair" Seaplane on May 21, 1927, when an average speed of 130.93 miles per hour for 1000 kilometers was made over the same short course. Lieut. Rutledge Irvine, U.S.N., Pilot.

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LONG ISLAND CITY **NEW YORK**

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Vol. No. 53, No. 7 Whole No. 293

Contents

REFLECTIONS ON THE AIRSHIP SITUATION
By Lieutenant Commander C. E. Rosendahl, U. S. Navy 745

INTERRELATIONS OF SEA AND AIR PROBLEMS
By the Hon. Edward P. Warner, Assistant Secretary of the Navy for Aëronautics 759

FLIGHT TRAINING OF STUDENT NAVAL AVIATORS
By Lieutenant Barrett Studley, U. S. Navy 764

AFTER JUTLAND
By R. H. Gibson 774

HYDROGRAPHIC SURVEYING WITH AIRCRAFT
By Lieutenant Logan C. Ramsey, U. S. Navy 777

AIRPLANE RACING AND RECORD CHASING
By Lieutenant F. W. Wead, U. S. Navy 782

AIR OPERATIONS IN PALESTINE
By Lieutenant Forrest Sherman, U. S. Navy 787

AIR MAPPING IN HAITI
By First Lieutenant Hayne D. Boyden, U. S. Marine Corps 793

DISCUSSION 797

PROFESSIONAL NOTES 801

NOTES ON INTERNATIONAL AFFAIRS 814

BOOK REVIEWS 820

SECRETARY'S NOTES 824

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PN-10 Navy Patrol Plane (Three-quarters Front View)
Two Packard 1500 Geared Engines

PN-10 Navy Patrol Plane (Three-quarters Front View)
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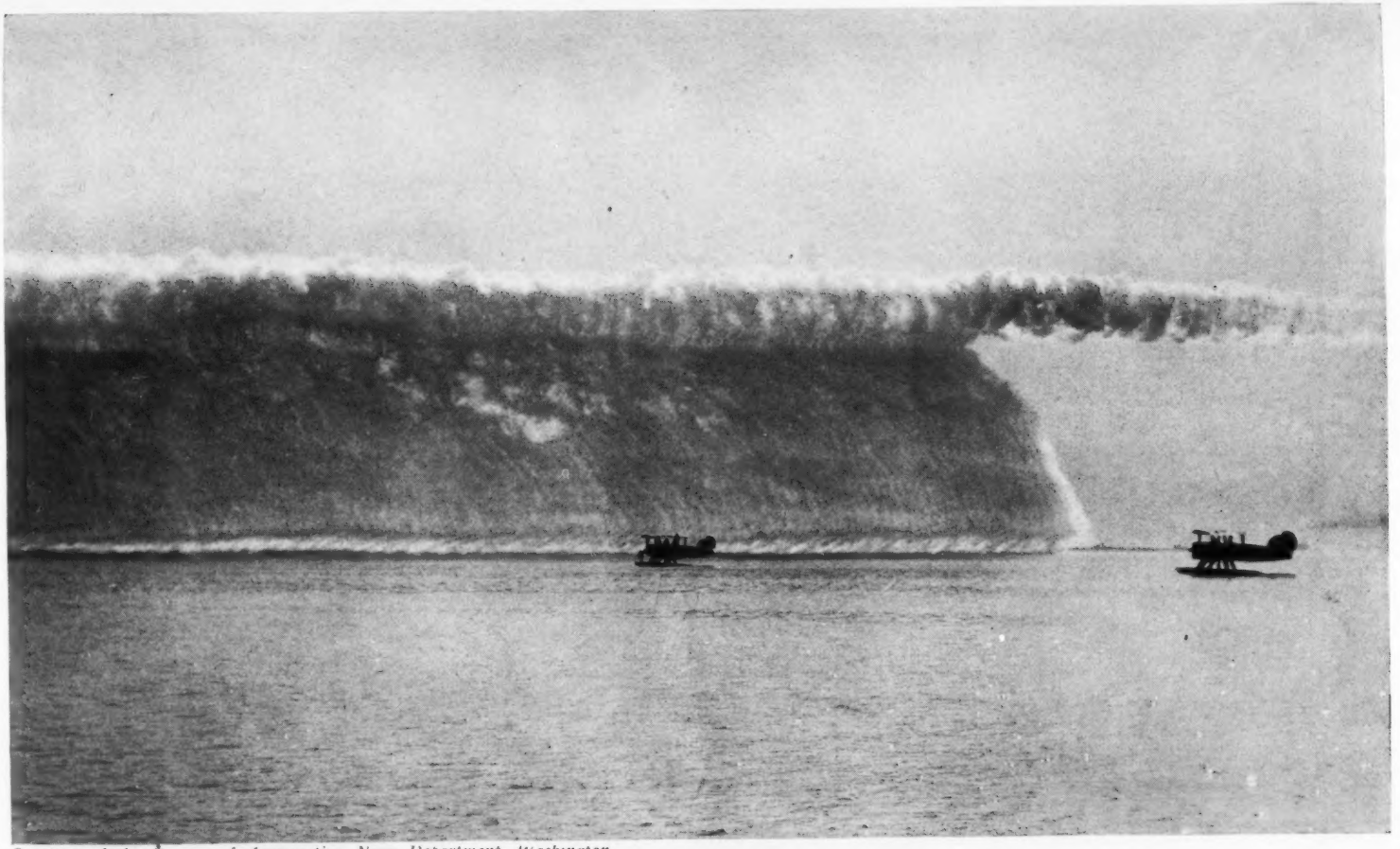

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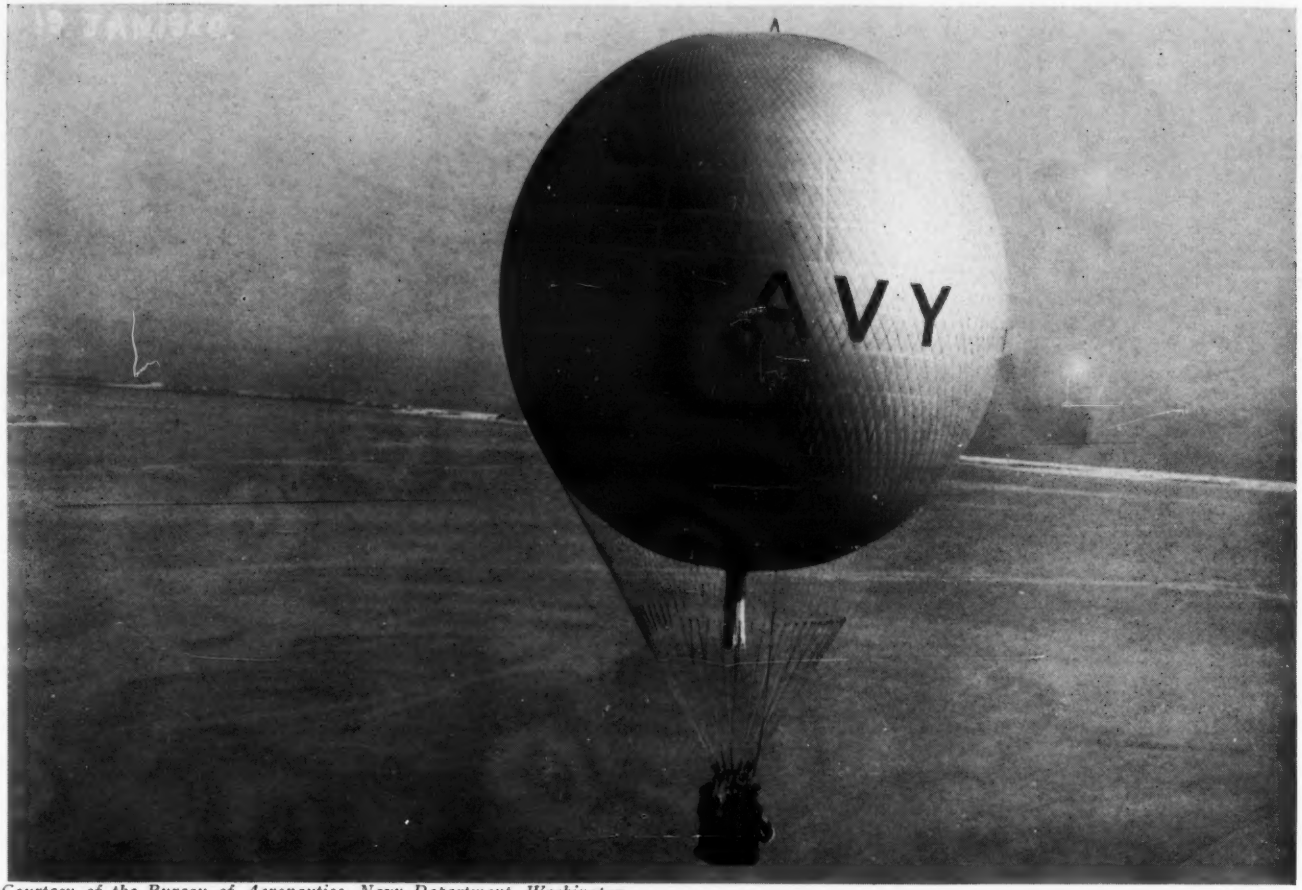
Navy Seaplanes—Smoke Screen Being Laid



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FREE BALLOON TEST FLIGHTS—NAVAL AIR STATION, LAKEHURST, NEW JERSEY

These flights are for preliminary training in the course to qualify for the handling of the large dirigibles

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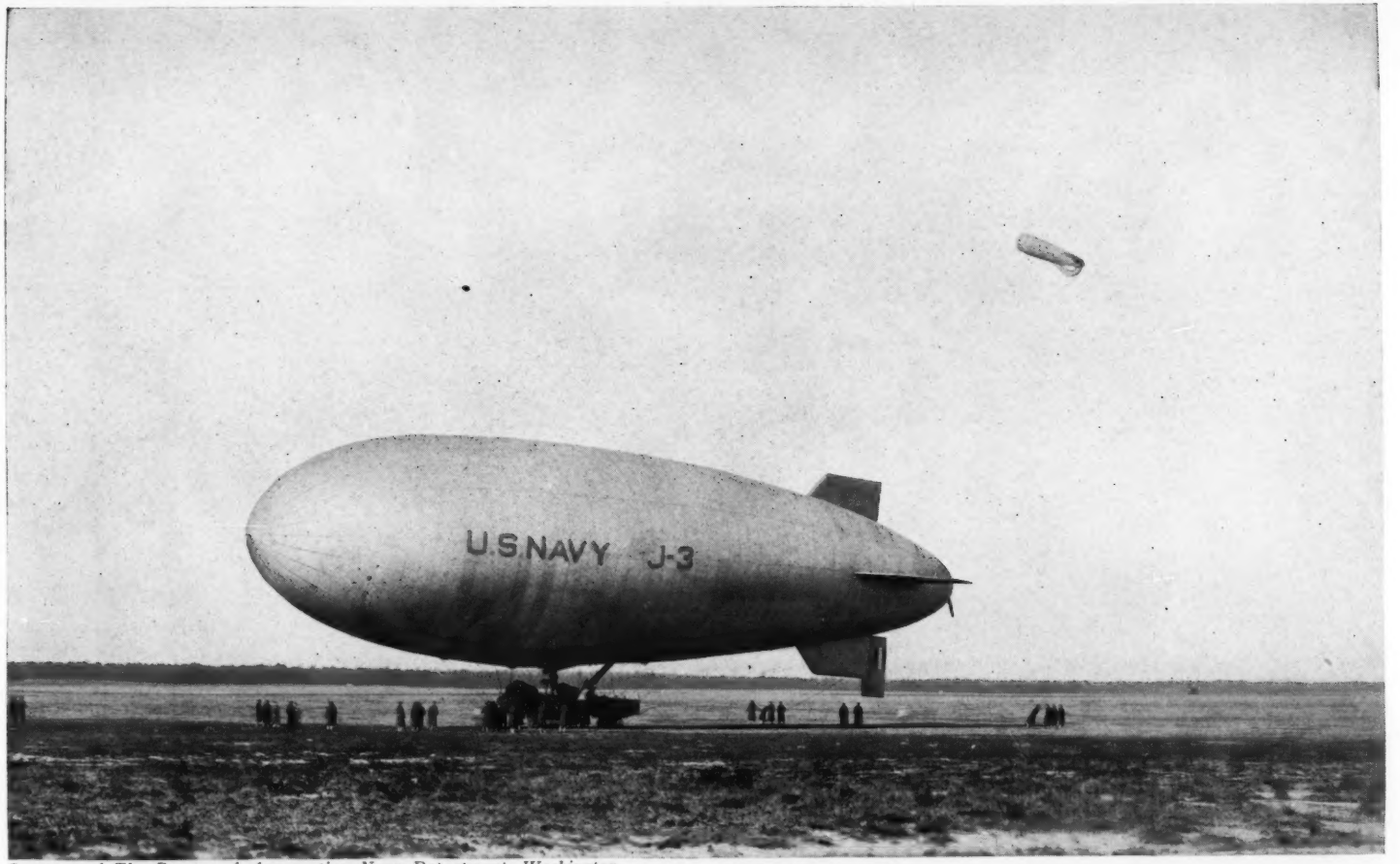

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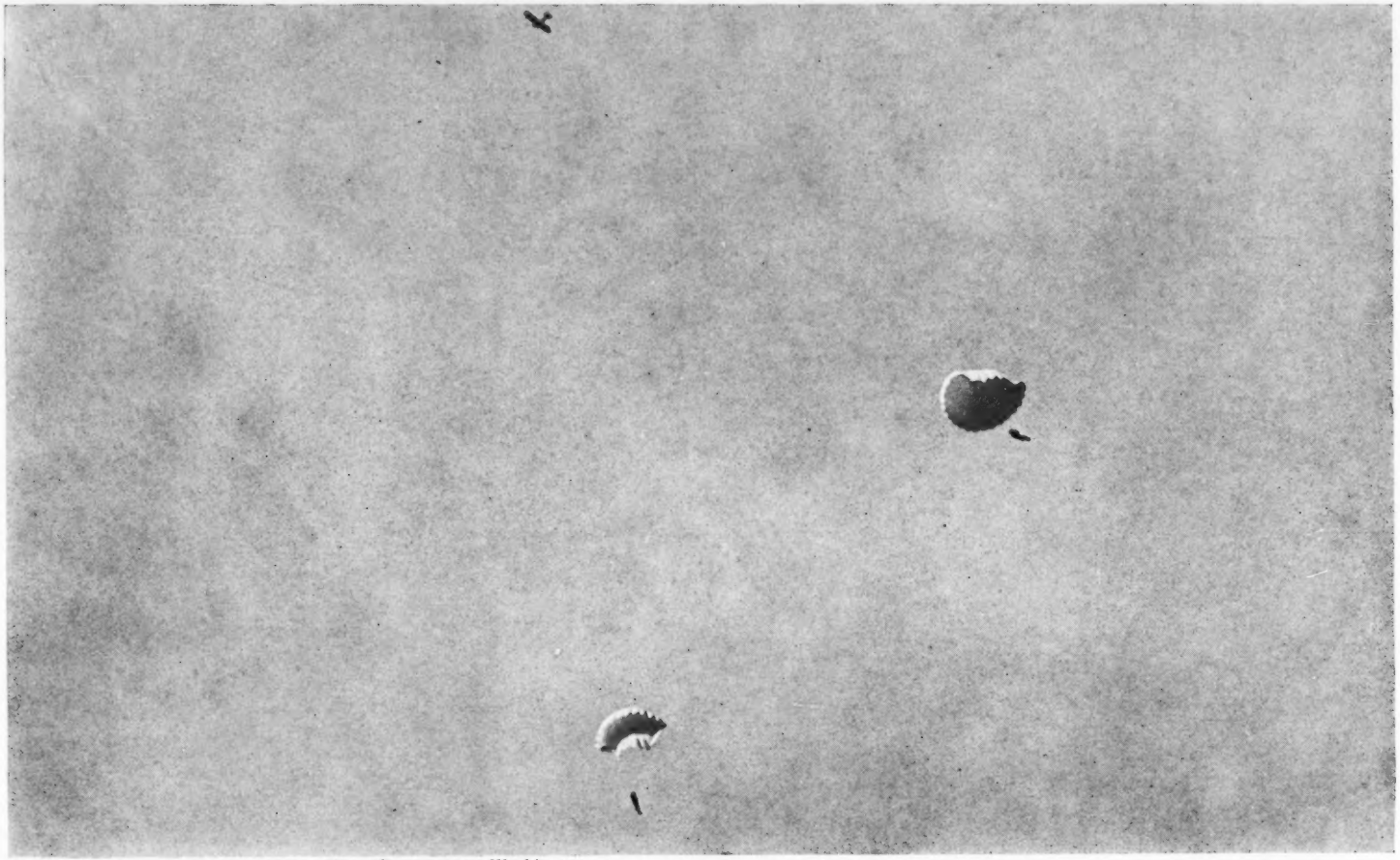
FURTHER PRELIMINARY TRAINING IS REQUIRED AT LAKEHURST IN THE SMALL NON-RIGID TYPES AS WELL AS IN KITE BALLOONS, ONE OF WHICH IS SEEN TO THE RIGHT AND ABOVE "J-3."

Courtesy of Bureau of Aeronautics, Navy Department, Washington

READY TO LEAP—PARACHUTE JUMPER OUT ON WING OF PLANE

Courtesy of Bureau of Aeronautics, Navy Department, Washington

ABOUT TO LAND—SPOT LANDING



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DOUBLE PARACHUTE JUMPS

Courtesy of Bureau of Aeronautics, Navy Department, Washington

A SINGLE JUMP WITH TWO PARACHUTES

Courtesy of Bureau of Aeronautics, Navy Department, Washington

A Parachute Jump by T. D. Ferguson, Aviation Machinist Mate, Second Class, U. S. Navy, from Navy Plane over San Diego, California

A Parachute Jump by T. D. Ferguson, Aviation Machinist Mate, Second Class, U. S. Navy, from Navy Plane over San Diego, California

Courtesy of the Glenn L. Martin Company, Cleveland, Ohio

T3M-2 Three-Purpose (Bombing, Torpedo and Scouting) Plane, with Packard 3A-2500, 800 H.P. Motor, 100 of Which are Being Built by the Glenn L. Martin Company for the United States Navy

Courtesy of the Pratt and Whitney Aircraft Company, Hartford, Connecticut

CURTISS SEA HAWK EQUIPPED WITH PRATT AND WHITNEY WASP ENGINE
This plane was submitted to the Navy Department as a shipboard fighter.

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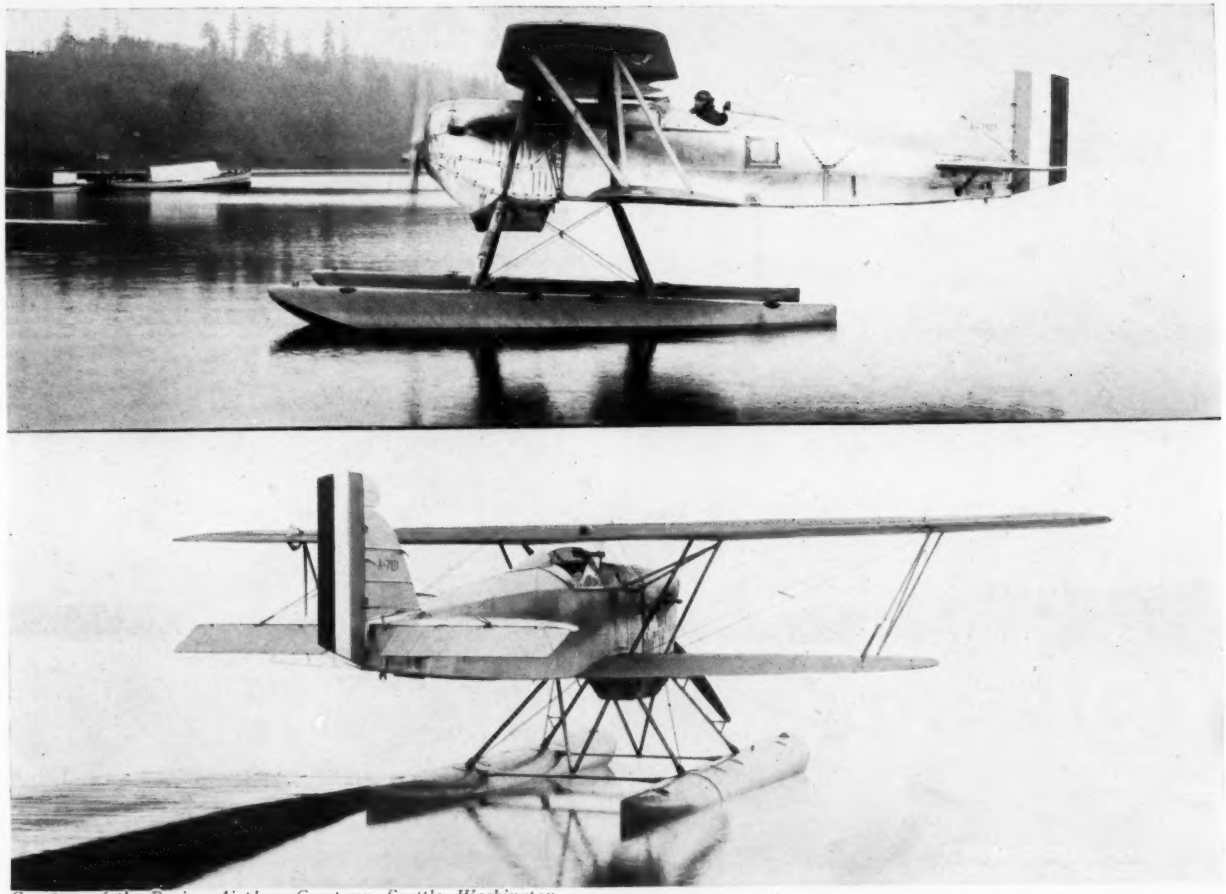
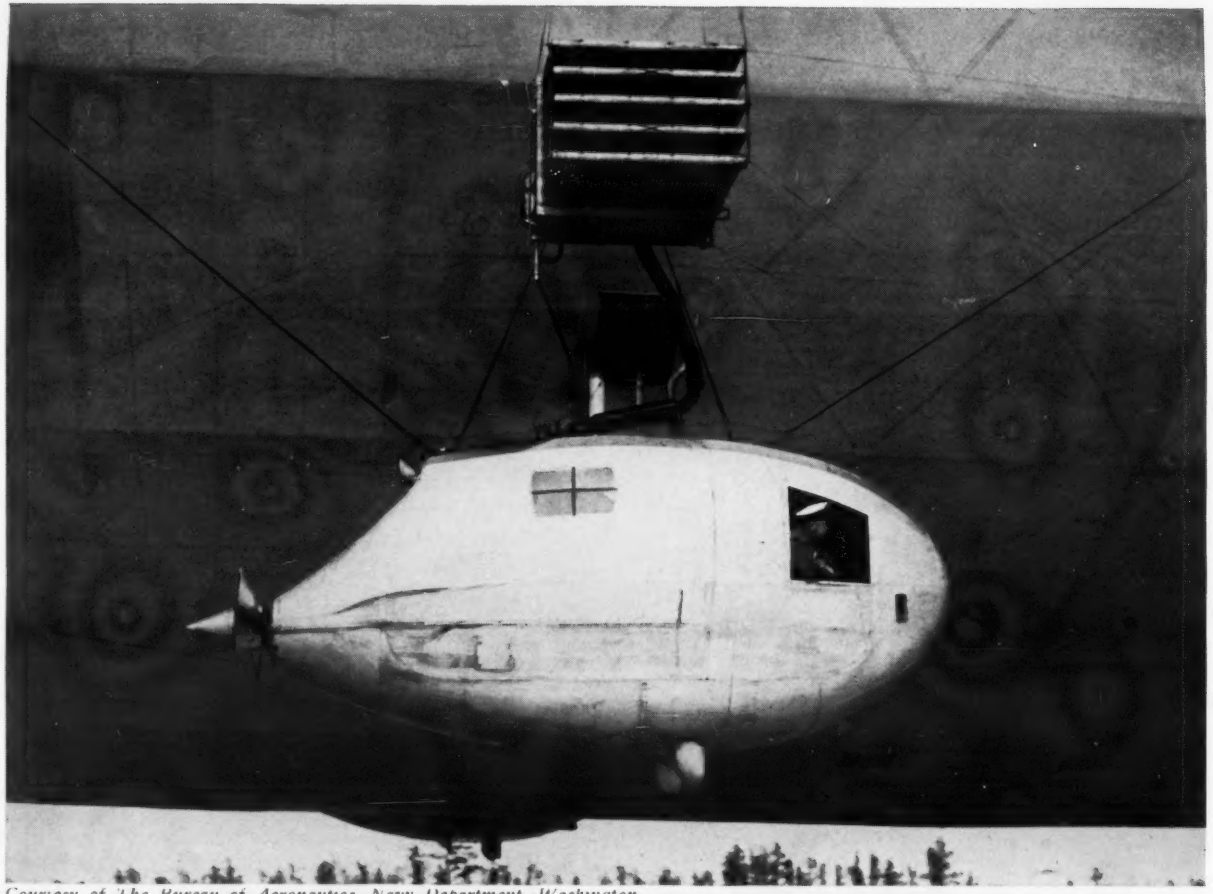


Courtesy of the Boeing Airplane Company, Seattle, Washington

THE BOEING FIGHTER OR COMBAT SEAPLANE

Courtesy of the Douglas Company, Santa Monica, California

DOUGLAS T-2-D TWIN ENGINE AIR-COOLED HAMBURG AIRPLANE EQUIPPED WITH PONTOONS



Courtesy of The Bureau of Aeronautics, Navy Department, Washington.

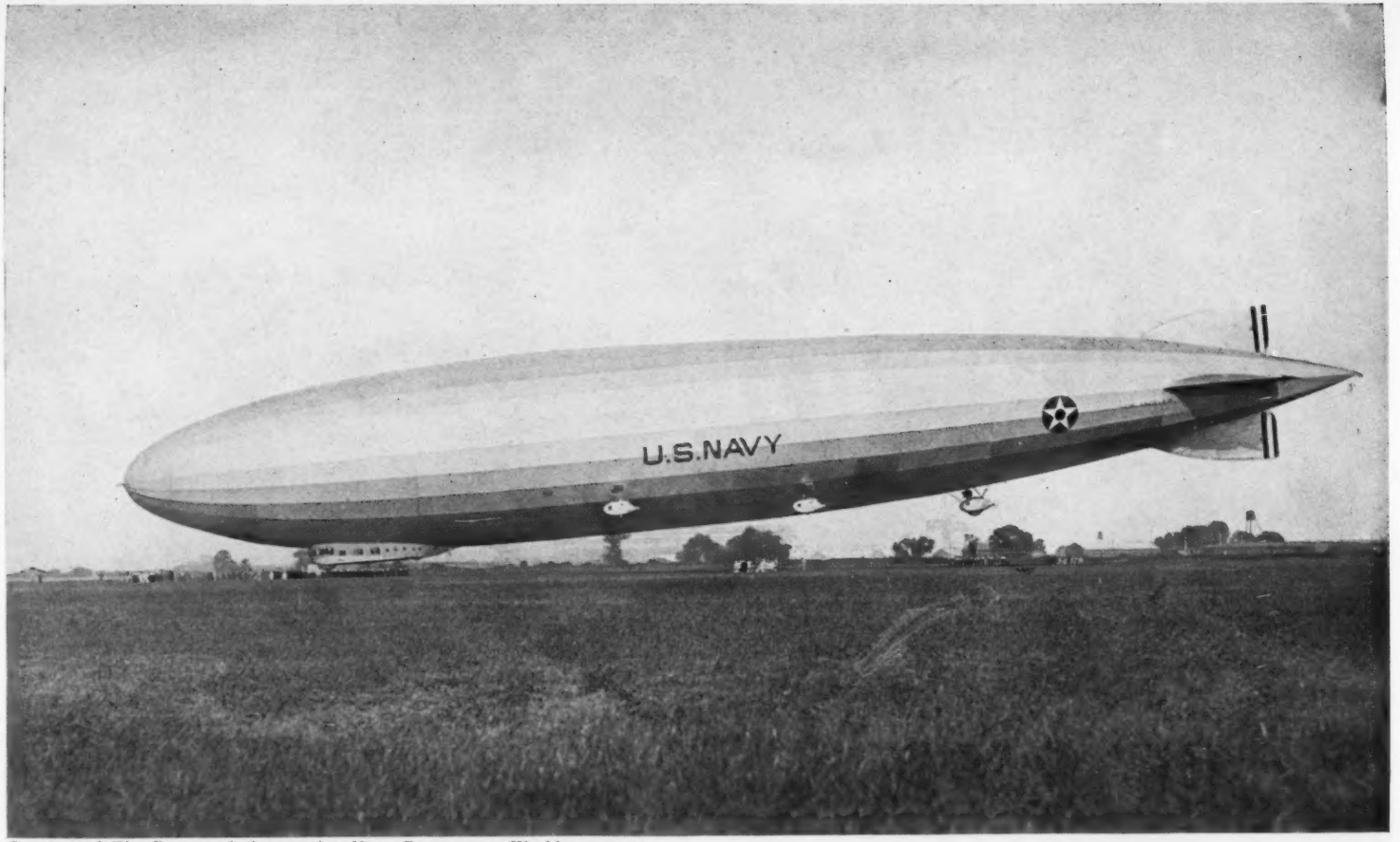
View of Wing Power Car, Starboard Side, "Los Angeles,"
Showing Water Recovery Apparatus Above Car

Courtesy of The Bureau of Aeronautics, Navy Department, Washington.

THE "LOS ANGELES" SAILING OVER THE CAPITOL AT WASHINGTON

Courtesy of The Bureau of Aeronautics, Navy Department, Washington.

THE "LOS ANGELES" SAILING OVER THE CAPITOL AT WASHINGTON



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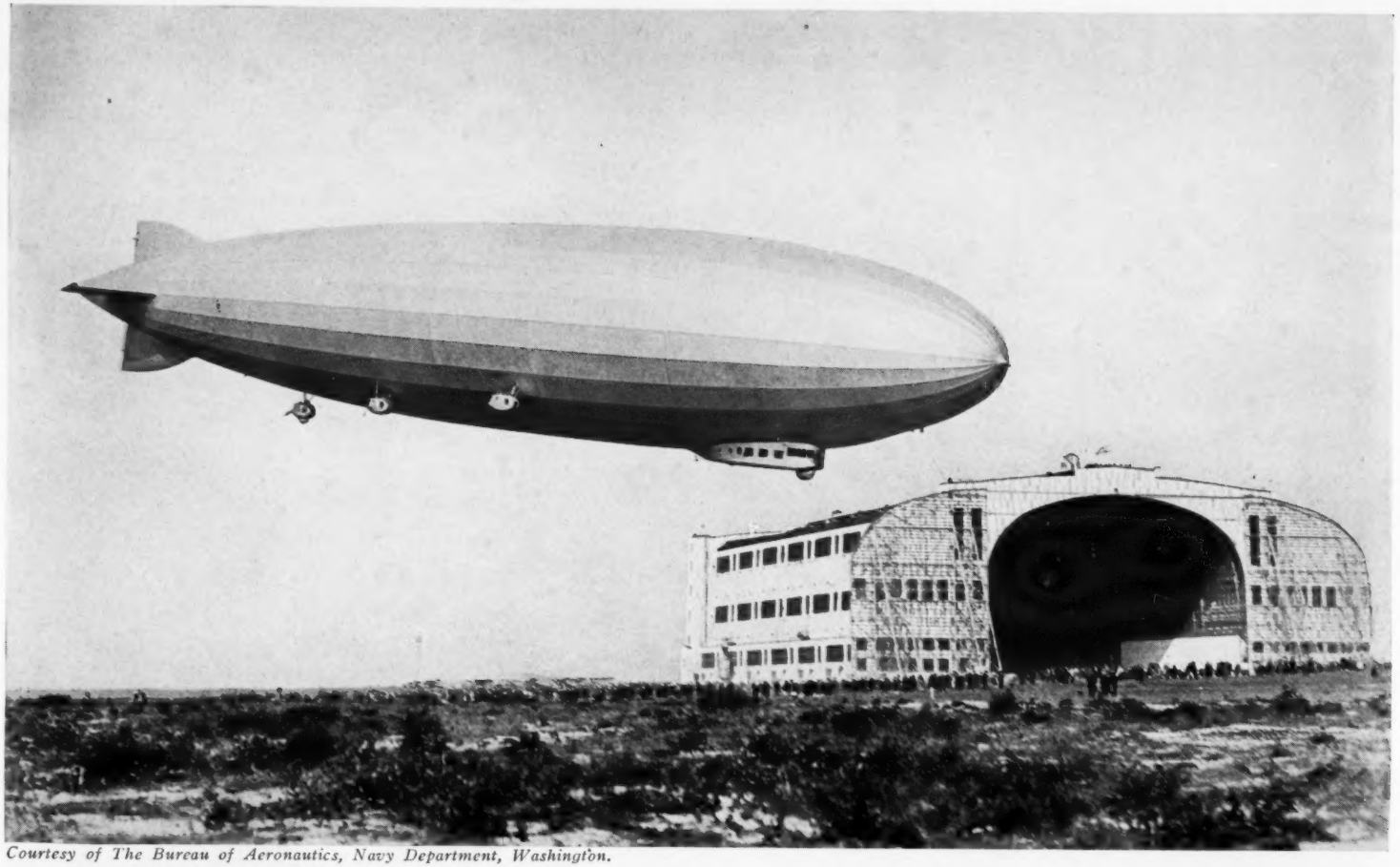
THE "LOS ANGELES" LANDING PREPARATORY TO BEING "WALKED" TO THE HANGAR BY THE LANDING CREW



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THE "LOS ANGELES" CIRCLING THE LANDING FIELD AT LAKEHURST, PREPARATORY TO MAKING HER LANDING AND BEING TAKEN INTO THE HANGAR

The ship is 656 feet long, 90 feet wide, and 101 feet high. The hangar is large enough to house completely the Capitol at Washington, except for the dome. The Union Station at Washington could be placed inside without touching in any place. The Woolworth Building if placed on its side could be placed inside with room to spare.

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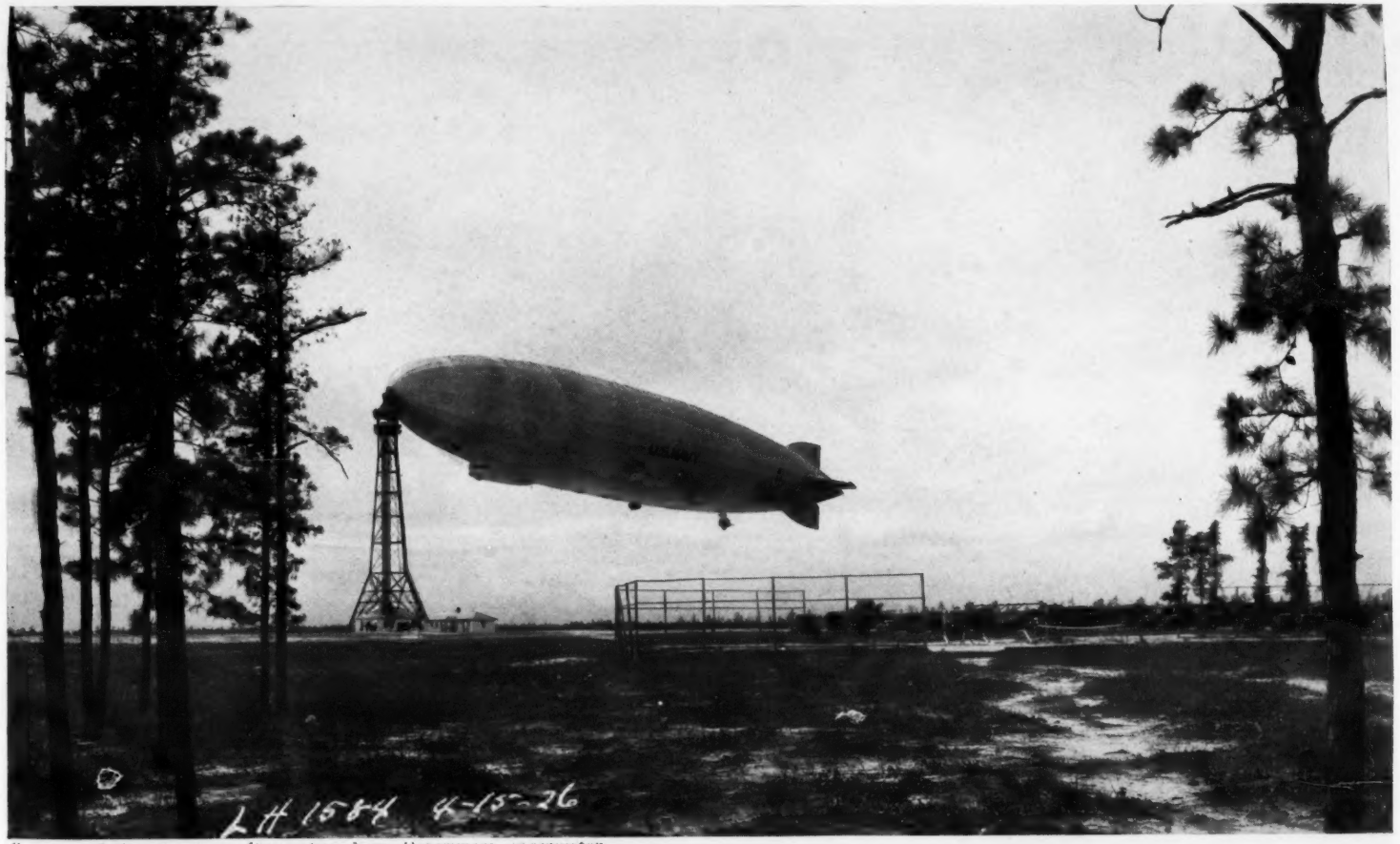

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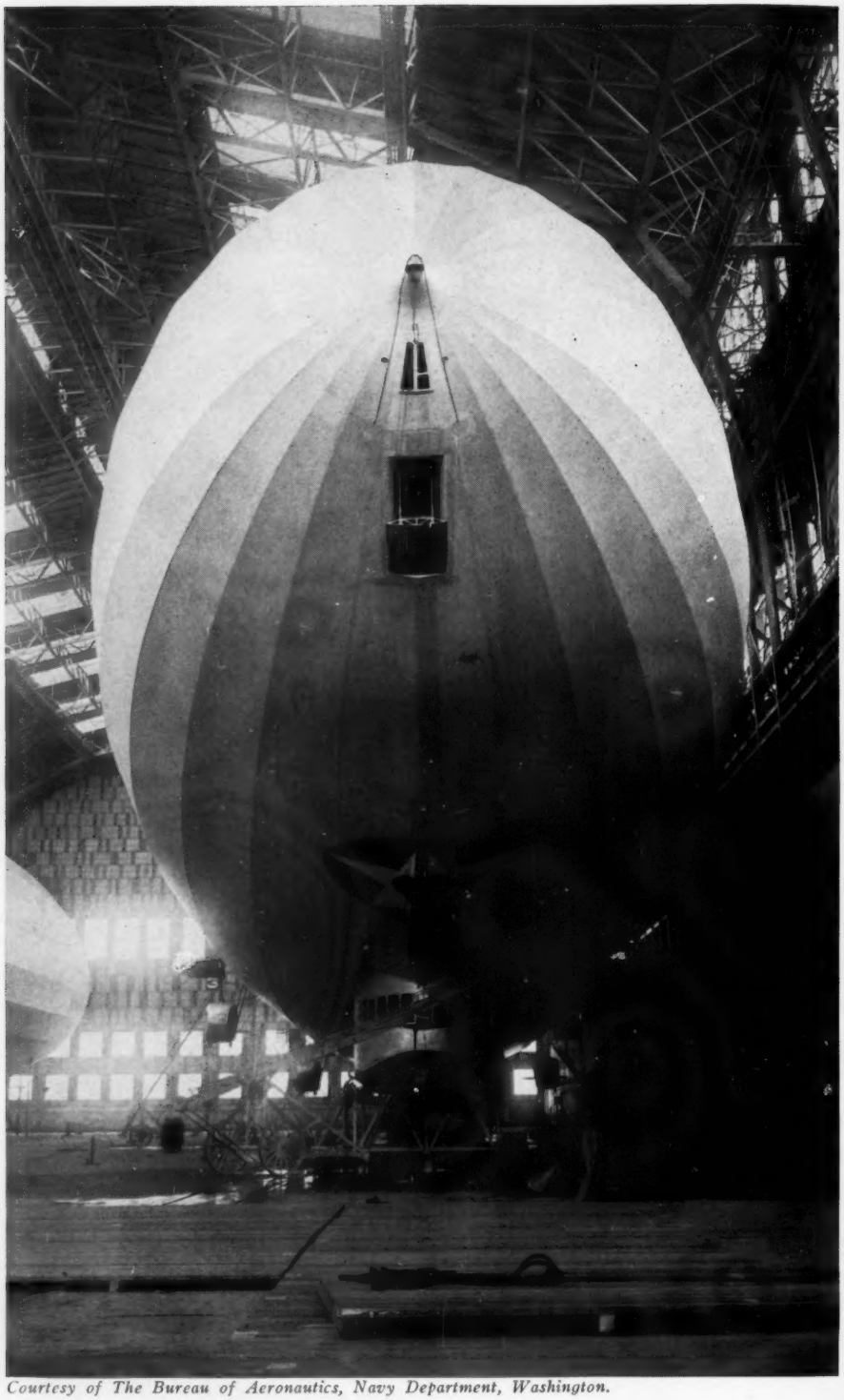
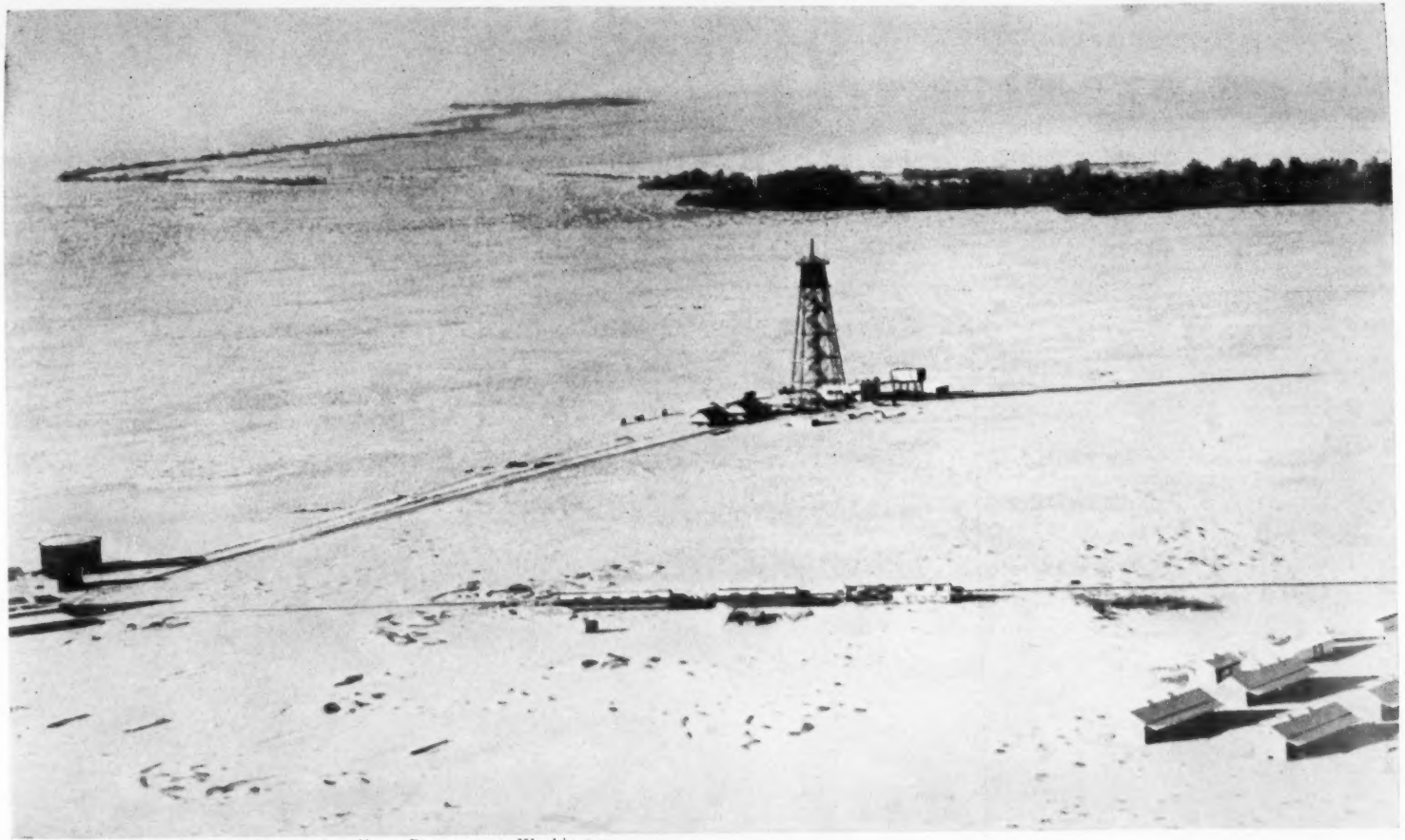
U.S.S. "LOS ANGELES" AT MAST, LAKEHURST, N.J.



Courtesy of The Bureau of Aeronautics, Navy Department, Washington.

"Los Angeles" in the Hangar at Lakehurst

Three Dreadnaughts of the type of the *West Virginia*, if they could be placed alongside of one another, could be housed in this hangar.



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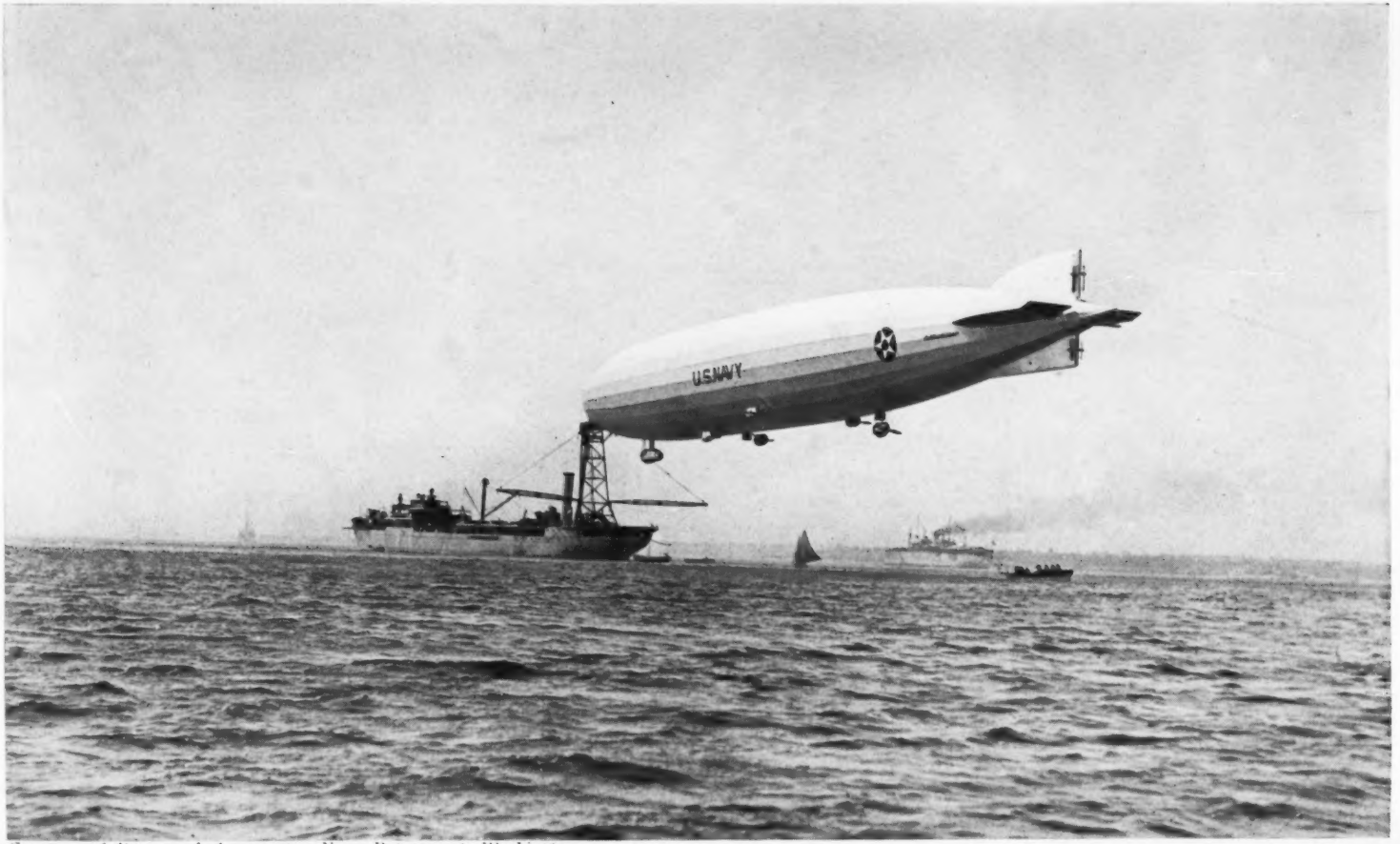
THE INTERMEDIATE REFUELLING BASE IN COURSE OF CONSTRUCTION AT ISMAILIA, EGYPT
(Taken from a British publication)



Courtesy of Bureau of Aeronautics, Navy Department, Washington

U.S.S. "Shenandoah" Moored to U.S.S. "Patoka" in Narragansett Bay

Courtesy of Bureau of Aeronautics, Navy Department, Washington

U.S.S. "SHENANDOAH" MOORED TO U.S.S. "PATOKA" IN NARRAGANSETT BAY

Photograph from Wide World Photos.

COMMANDER BYRD'S GIANT THREE ENGINED FOKKER MONOPLANE "AMERICA"

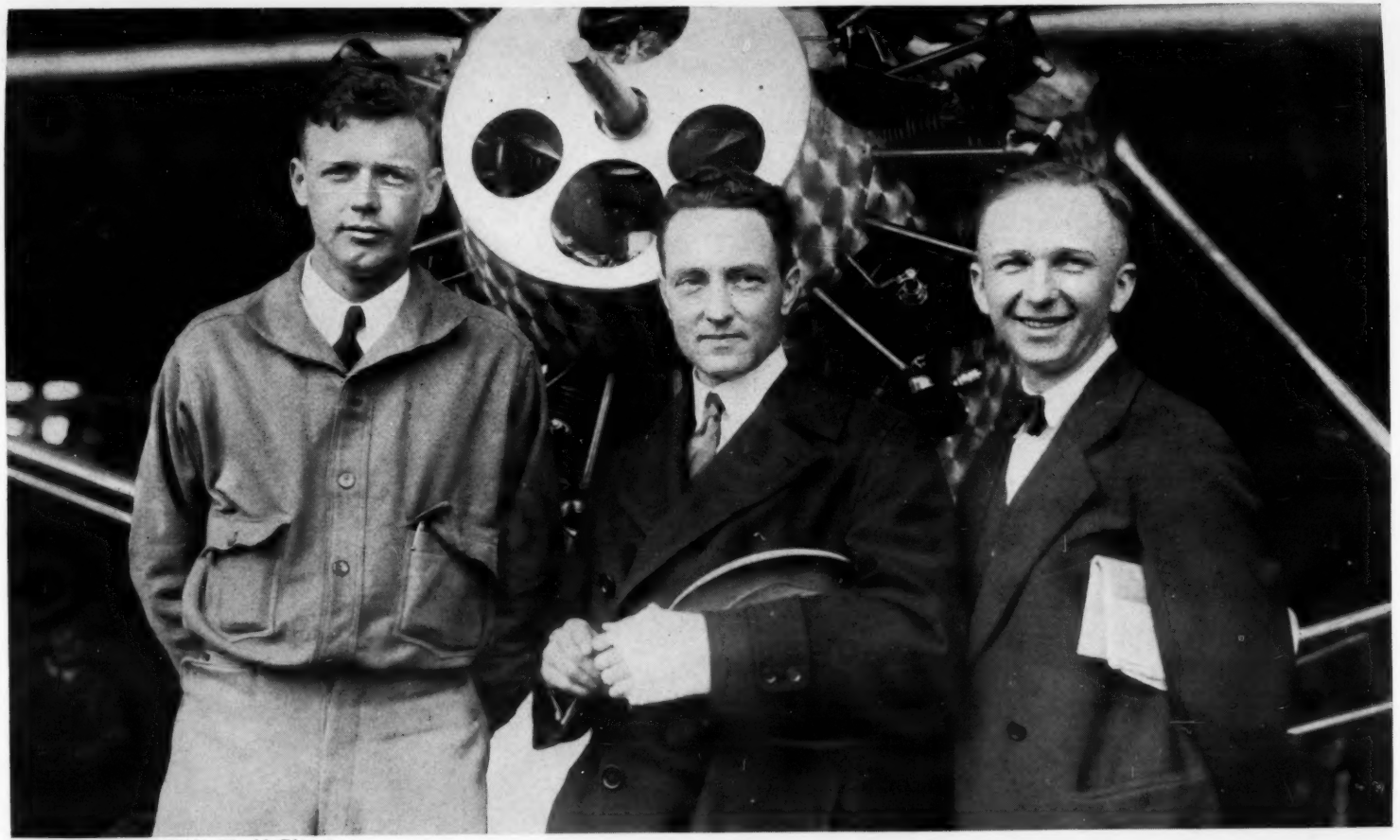
Photo shows the plane releasing water from her gas tanks to determine how much time it takes to empty gas tanks in case of forced landing at sea. It took three minutes. In the contemplated transatlantic flight Byrd chose Bert Acosta and Lieutenant Noville as assistants.

Photograph from Wide World Photos.

THE SINGLE ENGINED MONOPLANE "COLUMBIA" IN WHICH CLARENCE CHAMBERLIN WITH CHARLES A. LEVINE FLEW FROM NEW YORK TO EISLEBEN, GERMANY, 120 MILES FROM BERLIN, BEING FORCED DOWN BY FUEL EXHAUSTION

Photograph from Wide World Photos.

THE SINGLE ENGINED MONOPLANE "COLUMBIA" IN WHICH CLARENCE CHAMBERLIN WITH CHARLES A. LEVINE FLEW FROM NEW YORK TO EISLEBEN, GERMANY, 120 MILES FROM BERLIN, BEING FORCED DOWN BY FUEL EXHAUSTION



Photograph from Wide World Photos.

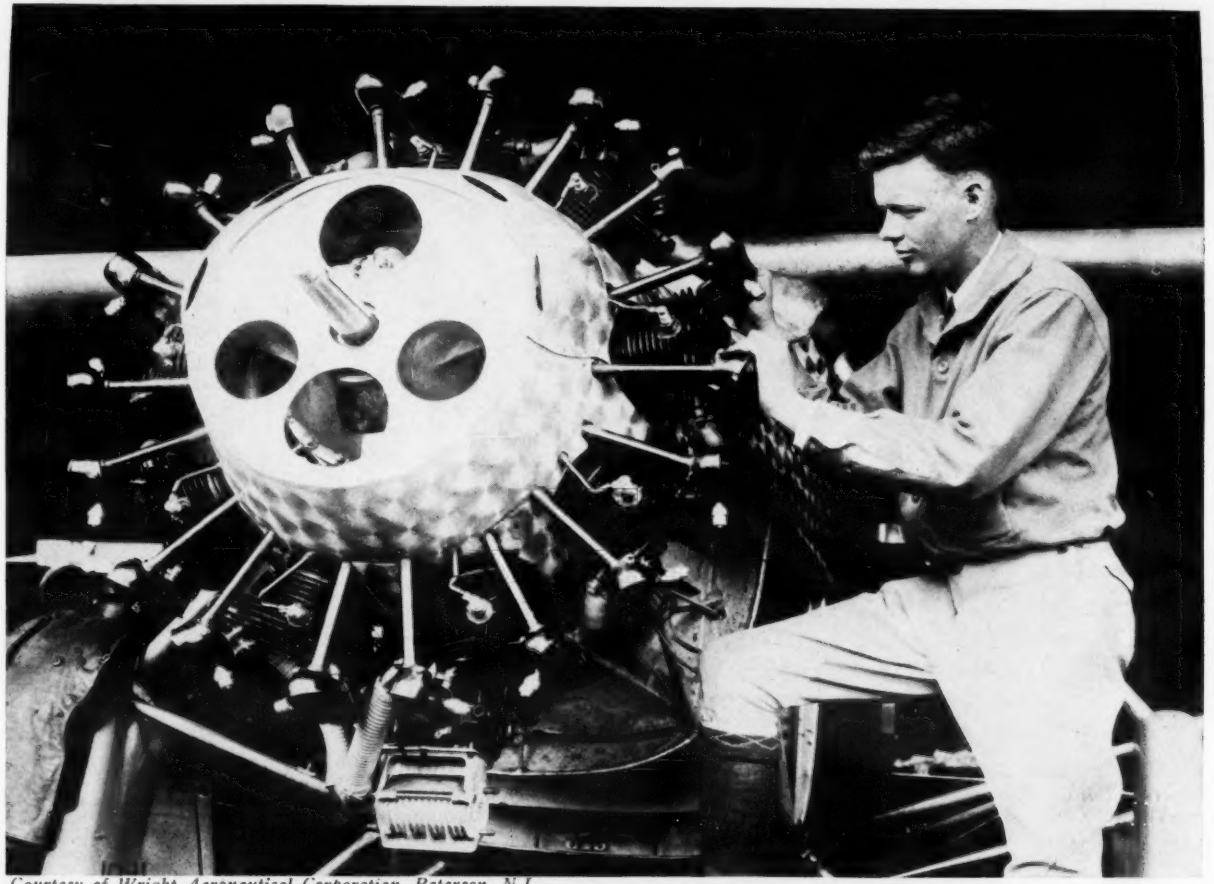
LEFT TO RIGHT: CHARLES LINDBERGH, COMMANDER BYRD, AND CLARENCE CHAMBERLIN. LINDBERGH'S PLANE "SPIRIT OF ST. LOUIS" IN HANGAR, ROOSEVELT FIELD, LONG ISLAND.

Courtesy of Wright Aeronautical Corporation, Paterson, N.J.

LINDBERGH'S "SPIRIT OF ST. LOUIS"—POWER PLANT "WRIGHT WHIRLWIND," 200 H.P. AIR-COOLED ENGINE. (SAME TYPE ENGINE IN CHAMBERLIN'S "COLUMBIA").

Courtesy of Wright Aeronautical Corporation, Paterson, N.J.

LINDBERGH'S "SPIRIT OF ST. LOUIS"—POWER PLANT "WRIGHT WHIRLWIND," 200 H.P. AIR-COOLED ENGINE. (SAME TYPE ENGINE IN CHAMBERLIN'S "COLUMBIA").



Courtesy of Wright Aeronautical Corporation, Paterson, N.J.

LINDBERGH AND THE "WRIGHT WHIRLWIND" 200 H.P. AIR-COOLED ENGINE, WHICH RAN FOR 33½ HOURS IN FLIGHT OF 3,647 MILES, NEW YORK TO PARIS; FUEL CONSUMPTION LESS THAN 12 GALLONS PER HOUR, OR OVER 9 MILES PER GALLON

Photograph from Wide World Photos

LINDBERGH'S MONOPLANE, "THE SPIRIT OF ST. LOUIS" IN TEST FLIGHT OVER SAN DIEGO PREPARATORY TO TRANSATLANTIC FLIGHT NEW YORK TO PARIS.

Plane has single engine and can carry two and one-half times its own weight.

UNITED STATES
NAVAL INSTITUTE
PROCEEDINGS

Vol. No. 53, No. 7 JULY, 1927 *Whole No. 293*

Reflections *on the* Airship Situation

By LIEUTENANT COMMANDER C. E. ROSENDAHL, *U. S. Navy*

THE Sixty-ninth Congress recently enacted a law providing for a five-year aircraft building program, the naval portion of which includes the construction of two naval rigid airships each of 6,000,000 cubic feet lifting gas capacity. An appropriation for beginning the construction of the first of these becomes available at the beginning of the fiscal year 1928 and a competition for the design of this huge airship closed on May 15, 1927. By joint agreement with the Army, the Navy is charged with the development of rigid airships in this country and has been the only agency engaged in the United States in rigid airship operation. Fortunately, the commercial side so far has paralleled the naval phase of airship development, as the real usefulness of airships for either purpose cannot be achieved until certain necessary auxiliary features have been developed; therefore our naval efforts have a direct influence on the commercial future of airships. Since our one present rigid airship, the *Los Angeles*, cannot be used for military purposes, it is our present plan to utilize her for valuable training and experimental purposes and for the development of auxiliary features that our experience has now shown us to be desirable and essential. When these have been achieved, a considerable extension of airship operations is bound to follow.

Airship activity is not by any means restricted to the United States. Great Britain is building two rigid airships each of 5,000,000 cubic feet capacity plus suitable bases for quicker commercial contact with her outlying colonies. The first of these ships should be ready within a year. Germany is building, largely by popular subscription, the largest airship her remaining sheds will hold, over 1,000,000 cubic feet greater in volume than the *Los Angeles*. Intended at various times for scientific exploration of the Arctic, it is now assured that this ship, the *LZ-127*, will become the first of a line of airships to be operated by Spain under government subsidy between Seville and the Argentine. Japan is indulging in experimentation and operation of the semirigid type airship and General Nobile of polar fame is in Japan today with assistants instructing the Japanese in the art of airship operation and construction. Even Soviet Russia is reliably reported interested in airships of the semirigid type at present.

This widespread revival of interest and activity in airships naturally leads to discussion of the merits of the airship project. Of hear-say critics, airships have the usual numbers that any new project has. Since only comparatively small personnels were engaged in the airship operations of the past, there are really very few people qualified to pass upon the merits of airships from the standpoint of actual contact, first-hand information, and experience. Moreover, since airships of the past were operated under restricted or even artificial conditions and since it is generally the unfortunate and unsuccessful features that have received the greater publicity, it is logical that there should exist some doubt concerning the value of airships. It is not the intention in

LINDBERGH'S MONOPLANE, "THE SPIRIT OF ST. LOUIS" IN TEST FLIGHT OVER SAN DIEGO PREPARATORY TO TRANSATLANTIC FLIGHT NEW YORK TO PARIS.
Plane has single engine and can carry two and one-half times its own weight.

this article to indulge in a full discussion of the merits of airships; but one cannot proceed on the subject without attempting to dispel some of the existing doubt by pointing out a few of the salient factors in the history of airships that have escaped public attention largely because this information has not been available as freely as have other features. This article is intended in no sense whatsoever as an apology but has for its main purpose the endeavor to show that airships have been restricted by certain features yet undeveloped, some more or less logically so, that have made a full and fair demonstration of airship capabilities generally impracticable.

Since the rigid airship has been brought from inception to its present status largely by German effort, naturally we look to German experience and history for information and guidance. In making such an investigation, we find that personnel problems were a serious factor in the German naval airship service. It is known from authoritative sources that at the beginning of the war the Germans almost totally lacked experience in the use of airships in naval warfare. Few of the German airship commanders in the World War were sufficiently indoctrinated in naval warfare to make the best use of their ships. The great demands of other branches such as the heavier-than-air and submarine services did not allow as strict a choice of personnel as the best interests of the airship service demanded. Being at war, the production of ships exceeded that of fully trained personnel; only short periods of training could be afforded and naturally such training lacked peacetime thoroughness. Owing to lack of experience in scouting a number of mistakes and failures occurred during the war, especially because the newly trained commanders were obliged to devote the greater part of their attention to the technicalities of airship handling and so neglected the military demands made upon them. Another fact that prevented the airship service from yielding the very best results was that many commanders lacked the necessary military schooling, so that they failed to comprehend how important in naval warfare was the correct execution of orders and allowed themselves to be sidetracked by secondary circumstances. The physical and technical demands of the service required young men and it was also easier to train them rapidly; older commanders lacked the necessary mental adaptability and so the lesser evil of insufficient military schooling was chosen. Tactical training was utterly impossible owing to the war and the distance of the airship ports from one another. Very often a commander misjudged the importance of an operation and detained by the captivating sight of a naval encounter with enemy forces, failed entirely to execute his orders. Too often the commanders overrated bad weather and often at a distance of only a few miles much better meteorological conditions prevailed, so that had they gone on would have been able to execute their missions. The thorough military schooling of some of the commanders was apparent for they grasped the importance of their orders and executed them correctly at all costs, under all sorts of unfavorable conditions even at the risk of losing their ships. Nothing that has been stated above can possibly be taken as a reflection on the courage and devotion of German personnel to their cause, but it is well recognized that bravery and daring alone cannot offset the lack of fundamentals in military training.

Surely no one would condemn the value of any weapon because of personnel failures connected with it. Most of us do not subscribe to certain phases of the World-War German submarine employment, yet no nation has excluded the submarine because of certain past improper employment. Similarly, German airships were employed on bombing or raiding missions under conditions that we might probably never tolerate or contemplate, and even though many of these raids were failures due to the inherent inability of these primitive airships to withstand the hazards of such duty, one cannot in fairness denounce the airship because it failed where improperly employed. Although early raids achieved some success, perhaps no one realized better than the Germans themselves the unsuitability of their airships for raiding; but this diversion from other routine work and the effect on England were worth some losses. Even though one airship commander on scouting duty sent in erroneous information of great import, his mistake cannot be fairly charged to the airship which merely carried him to the scene of his faulty deduction.

The argument of airship vulnerability from enemy attack is a popular one but I believe almost any one, after close considera-

tion, will grant the airship a very good chance of escaping destruction from an enemy. Proper employment of the airship should greatly reduce the liability to attack from enemy planes, for there is no doubt a limit to the number and types of planes that an enemy will have at sea that he could or would be willing to despatch after an airship scout and the prospects of being able to return safely to the carrier would largely govern this. But should an airship be attacked by planes, she is far from helpless for with her armament of defensive planes, well distributed larger caliber guns and steadier platform, excellent maneuverability and climbing ability, her defense is not as negligible as it might seem. Bombing a maneuverable airship from high speed planes is not such an accurate matter. Inflation with inert helium instead of inflammable hydrogen eliminates the greatest single factor in the destruction of rigids by enemy attack. Holes through gas cells and cover can be patched expeditiously with little loss of buoyancy particularly in the larger projected ships where the size of structural members will permit almost unlimited access. German airships have returned to their bases with as many as one-third of their gas cells deflated. One cannot hope to get back his scouting forces unimpaired and the information obtainable might easily be worth the expenditure of the scout; but the loss of large airships while carrying out purely naval missions has been negligible.

The alleged airship enemy that one hears the most of, however, is the weather. Every weapon seems to have limitations imposed upon its efficiency by the weather and even our stolid surface craft are not immune. Furthermore, it may be possible that aircraft will never be entirely independent of weather but it is my opinion that this common plea has been abused at times because of other shortcomings. Even should some dependence of aircraft performance on weather always exist, that should not necessarily mean our abandonment of flying simply because of partial dependence on a medium of which at the present we know a great deal and yet actually only very little of what we need to know. Surely a man's knowledge will increase as the necessity for deeper study of weather becomes recognized sufficiently. Too much non-performance of airships has in the past been charged to weather and erroneous impressions thereby created but as all aircraft are still in their infancy, it is my impression that attention must be paid to natural atmospheric phenomena and weather to minimize aircraft mishaps while we learn to achieve greater independence of the elements. Airships of present and even the crude past designs have flown through extremely turbulent atmospheric conditions. The newer and stronger ships to come can surely do even more, for there is no reason to believe that the fury of nature will increase and parallel man's advances against her. Airship personnel have always demanded more speed and it is interesting to note that as airships become larger it is perfectly feasible to give them greater strength and greater speed and hence greater ability to combat the hostile forces of nature and of an enemy.

It is my opinion that airships have not yet had a fair chance to demonstrate their usefulness in spite of extensive German war experience. As indicated earlier, lack of properly indoctrinated commanders surely nullified to some considerable extent the naval usefulness of German airships and improper employment served to prejudice many persons against airships without any deep-seated reason therefor. Our own obsolete *Shenandoah* did engage in scouting problems but these of necessity were of very difficult proportions, i.e., one scout searching for a single vessel over a vast expanse. No other nation, as far as I have been able to learn, has made even peacetime use of rigid airships in conjunction with its navy. Perhaps it is true that in the past highly enthusiastic and pretentious claims were made for airships, for when rigid airships were taken up in this country, it was for us a new venture and, lacking operating experience, we could not anticipate fully what our difficulties were to be. But whatever may have been past promises, our present realization and the experience gained from our few years of airship operation under trying circumstances will very soon, I feel, bring results. I am told that submarines experienced a very similar struggle before they were proven and accepted.

The value of any weapon or device is relative and I doubt if there can be mentioned a single military or naval arm or unit which has full effectiveness under all conditions. No sincere exponent of airships will claim that airships are perfected instruments nor that we yet know their full capabilities.

It is to be regretted that a rabid few paint airships only with the free unrestricted superlative and seem to have forgotten, if they ever knew, that there are any difficulties in airship operation. No one claims that present airships operating with present facilities are fully efficient under every possible condition, but it must be admitted that under some conditions airships certainly can be of value. It therefore follows that airships are generically in the same status as other arms, i.e., their usefulness is not wholly universal. Being in their pioneer and experimental stage as yet, however, there is no one sufficiently competent or omniscient to say that future development will not or cannot produce an airship of a very much higher degree of efficiency. Certainly great promises are definitely indicated. It is only logical to proceed with airship experimentation and development until we achieve ships and their auxiliaries that enable us to reach a definite conclusion from fair and impartial service tests as to the value of rigid airships. While critics nearly always prove their value by pointing out the trees which the enthusiast cannot see for the woods, there are some who seem to base their criticism on early pioneering effort alone and fail to credit airships with any prospects of progressing. It does not now appear that aircraft will ever replace any existing surface type but surely there can be no objection to our adding a valuable auxiliary to our Navy. It is the opinion of those of us who have engaged in their operation, that rigid airships do possess a potential value to the Navy primarily for scouting and reconnaissance purposes that cannot, under most circumstances, be equalled by surface craft or other types of aircraft. Several of the leading naval commanders of the World War are on record in their belief in the naval value of airships. An abundance of airship data can be found in the Report (No. 122) of the House Naval Affairs Committee's Hearing on the Bill (H.R. 7375) to Further Increase Aviation in the Navy by the Replacement of the U.S.S. *Shenandoah,* dated January 13, 1926, and on the so-called Five-Year Aviation Program Bill (H.R. 9690) dated February 26, 1926.

Before entering upon a discussion of airship problems, I believe it well to point out certain flights of rigid airships of the past that indicate the order of the performance that may be expected to be exceeded by modern airships and to indicate the distinction from airplane employment. Should one gather the impression that perhaps some of these were "stunt" flights, I cannot do better than to call attention to an excellent article by Commander R. E. Byrd in the *World's Work* for November, 1926, on the "Defense of Stunt Flying" wherein the value of "stunt" flying is set forth clearly.

(*a*) Small commercial airships operated in Germany both before and after the war and carried 37,000 passengers without accident or mishap. Most of this was even before the war, as the post-war commercial ships had to be delivered to the Allies after only brief German operation.

(*b*) The German *L-59* in November, 1917, took off from Jamboli, Bulgaria, carrying a cargo of fourteen tons of medical supplies and small arms' ammunition to the besieged German East African Colonies. Just as the destination was about reached, an unfortunate radio message was received by the airship containing incorrect information that the German Colony had surrendered. She therefore returned to Jamboli without landing. Although she had been in the air for almost 100 hours and had traveled about 4,500 miles with her fourteen-ton cargo, upon landing she still had sufficient fuel for forty-eight hours' more flight.

(*c*) The round trip of the British *R-34* between England and the United States in July, 1919, was a noteworthy achievement, for that type and size vessel was already obsolete. She required 108 hours and traveled 3,600 miles on the westbound flight; seventy-five hours and 3,450 miles on the return trip.

(*d*) In October, 1924, our American built *Shenandoah,* modeled after the German 1916 war type *L-49* but completed in 1923, cruised across the continent, up the Pacific Coast and returned to Lakehurst, having covered over 9,000 miles in many kinds of weather, basing entirely on mooring masts for over nineteen days.

(*e*) The Zeppelin *Dixmude* in the hands of the French stayed aloft 118 hours or nearly five days, a world's record for aircraft.

(*f*) The *Los Angeles,* then designated only as the *ZR-3,* on her delivery flight from Germany covered over 5,060 miles in eighty-one hours, spanning the actual ocean expanse in sixty-one hours.

(*g*) The *Norge,* an Italian semi-rigid ship, on the Amundsen Polar Expedition

successfully battled the unknown Arctic on her transpolar flight in 1926.

The war missions carried out by airships were numerous and varied and included raiding, bombing, convoy, scouting, patrol, reconnaissance, search and capture of surface craft, direction of minesweeping, detection of submarines.

We know that rigid airships even in their present state of development are capable of transporting comparatively large loads (for aircraft) over considerable distances at fairly high speed; we know that we can construct ships to give increased performance over any yet built and that up to very large sizes, the efficiency of rigid airships increases with size; also we are generally successful in the performance of navigation and the other arts necessary to conduct an airship to the desired destination. In spite of these facts we do not claim that airships have attained a wholly satisfactory or final status; but fortunately the greatest of the problems that remain can be classed as "overhead," i.e., the auxiliary features; and we now believe that solutions are about to be attained—not necessarily in their final forms but solved fundamentally so that further development will be in the nature of refinement.

Every rigid airship now in existence is an heritage from Germany. German rigid airships—commonly referred to as "Zeppelins"—were built to specifications demanded by German war policy, to operate from German bases and under wartime demand where quantity production was the predominating factor. As a result, their ships sacrificed certain other features in order to stress flying qualities, and the ground handling considerations, for example, became a secondary issue in that improvement of early and fundamental methods was not seriously sought. Also, weather conditions at German bases generally do not compare with the more severe conditions under which we have to operate airships. The greatest single enemy of airships of the World War was the high inflammability of their inflation medium—hydrogen. The United States is fortunate in possessing a bounteous, in fact almost unlimited, supply of the non-inflammable helium—most of it yet in the ground however. Our adoption of helium to replace hydrogen as the inflation medium of lighter-than-air craft has involved considerably more than the mere releasing of hydrogen and the pumping in of helium; not only are changes necessary in the physical aspects of the ships themselves but also methods of peacetime operation have been influenced and revised largely because of the present necessity for conserving the very meager supply of helium which our limited pioneering efforts in helium extraction have so far made available. Even the development of modern ground handling methods has been held back somewhat by the necessity of concentrating on the transition from hydrogen to helium, for naturally it is not a wise policy to attempt too many simultaneous changes in any ship built for a different school of operation. And while all branches of the service have well realized the pinch of economy, it may not be amiss to mention that lighter-than-air efforts have also felt economy measures very distinctly, and full experimentation has not been possible, while even that indulged in has necessarily been very slowly accomplished.

The rigid airship project has had many knocks. Not only have there been various kinds of reactions from the public, but since lighter-than-air and heavier-than-air activities were separated a few years ago, there has developed an erroneous impression of airships in the minds of a number of heavier-than-air enthusiasts. This latter situation, I am very glad to believe, has been generally due to a misunderstanding of airships through enforced lack of contact, and to the misconception that airships aim to usurp the functions of airplanes and, in so doing, spend sums of money that superficially appear large. Of course these ideas are basically incorrect; the employment of airships to parallel the activities of airplanes would be as absurd as the use of seagoing steamers on ferry boat duty. Even though planes have succeeded in crossing the Atlantic, it will probably be a long time before they achieve such dimensions and capabilities as to make ocean crossings common and they may even have to await new principles of design; yet in the light of even present knowledge, airships can be built of such size along present principles as to make transoceanic passage easily feasible. As to expenditures, it does not necessarily follow that certain funds would have been allotted to airplanes or even surface craft had they not been appropriated for airships. It might be interesting to point out that careful esti-

mates show that for the last six years, $95 out of every $100 spent on aëronautical activity has been expended on heavier-than-air projects. Furthermore, one may derive an erroneous impression of expense unless it is realized that overhead costs sufficient for several airships, at least, are of necessity so far charged up to our one or two.

We have to contend also with radical ideas of other well-meaning airship enthusiasts. Sketchy ideas and designs, many lacking any basic understanding, pour in. Naturally, we should be very delighted to indulge in wide experimentation and to have airships of greater factors of safety and increased performance but should a new departure succeed in construction and its service tests and in supplanting former types, we cannot afford to be idle in gaining airship operation experience during the many years necessary to bring the new type up to the useful sizes and performances now possible with present types.

I have been asked on several occasions whether I consider that the point has been reached where it would be advisable for commercial enterprise to take up the exploitation of rigid airships in the United States. The answer for the present moment is obviously, "No," but I do not believe that such a moment is far removed if we are allowed to proceed unhampered along the experimental lines we are now following. The remaining problems on which commercial exploitation depends coincide largely with our naval problems; it certainly is not any danger of flying or the lack of comfort in airship transportation that holds off the moment of commercial entry—the number of requests to fly proves that.

In my opinion the development and operation of rigid airships in the United States have been influenced largely and principally by the following factors, bearing in mind that the U. S. Navy has thus far been the only operator of such airships in this country:

(*a*) Lack of airships; (*b*) Lack of airship bases; (*c*) Undeveloped handling methods and auxiliaries; (*d*) Insufficiency of the scope of the original helium project; (*e*) Relative importance of missions; (*f*) Lack of proper weather information service; (*g*) Miscellaneous.

(*a*) *Lack of Airships:* The fact that at no time have we had more than one rigid airship in operating condition has forced upon us great caution and has influenced operating decisions being made primarily with a view towards securing a high degree of safety for the ship itself, as the loss or serious injury to one ship would probably have spelled, temporarily at least, a cessation of airship operation in the United States regardless of whether the reasons were well-founded or otherwise. Hence, there have been numerous occasions when doubts as to the favorability of flying conditions have not materialized but when the exercise of our underlying caution has resulted in abandonment of flights. When it is desired to conduct experiments in flight with new equipment, it is necessary to put our one ship in the hangar, install the apparatus to be tried and then go out and fly when conditions are suitable. Then, when modifications are necessary, as is generally the case in any new field of endeavor, our one ship must be docked in the hangar and submitted to the changes. Naturally, with numerous projects demanding attention, we try to dovetail the experimental work so as to get as much flight as possible out of the one ship. But how necessarily different is our procedure and how much slower than in heavier-than-air, for example, or in surface ships, where experimental installations can be tried competitively and simultaneously on a number of similar, or different, planes or ships as desired. Of course we realize that the present difficulties of obtaining several ships at one time are practically insurmountable, everything considered. We should like very much, for example, to have a specially equipped, personnel training ship of about 1,250,000 cubic feet capacity which, being smaller, would consequently be more easily handled on the ground. We have had to forego the smaller ship in order to obtain ships adequate for service uses but the benefits would be many in relieving the larger ships of much of the fundamental flight training work.

I feel confident, however, that as soon as all phases of the airship art begin to advance together, most of the situations that we now feel are undue peace-time chances will come to be reasonable ones and become operating feasibilities.

(*b*) *Lack of Airship Bases:* Consideration of the matter shows that there is only one rigid airship base in the United States fitted for handling rigid airships—that is Lakehurst. The Army Station at Scott

Field could be so fitted but actually is not. Secondary bases such as are afforded by mooring mast stations are widely scattered and are now manned only by caretakers, except in the case of the airship tender *Patoka,* which is the most available of all. The nearest shore mast is at Detroit, an airline distance of about 500 miles from Lakehurst. But these masts are not wholly perfect and do not afford all we could desire. It can therefore be said that there are really only two places on the Atlantic Coast to which an airship can resort for servicing, except in an emergency: i.e., Lakehurst and the *Patoka.* The latter, even though of a secondary nature, has extended airship operations materially. Improved landing fields and facilities for airplanes now dot the United States at frequent intervals and not without considerable cost. With the development of a new mooring system now being worked out, we hope to be able, at a reasonable cost, to indulge in a generous and logical distribution of airship facilities. Through the agency of such bases, an airship can be serviced; can undergo certain repairs; can remain away from her home base for extended periods; can land at safer places when thunderstorms or worse conditions menace her home base; all, we hope, with greater all-weather efficiency than at present. As it is now, we generally have to try to pick conditions that will not be decidedly unfavorable at Lakehurst at the end of the flight; if conditions there are dangerous, there is no place to go unless to the *Patoka,* and she also may be affected by the same conditions.

The influence of location and local characteristics on the value of an airship base is now beginning to be appreciated in this country although the Germans long ago sensed this factor keenly. The same general principle applies to harbors for surface ships; for example, even deep and broad harbors in the Bay of Fundy probably would never achieve importance due to the tidal phenomena of that vicinity. Likewise, a harbor continuously beset by fog would never become popular or profitable. And so the location of our one present airship base cannot be passed over without comment. When Lakehurst was decided upon as an airship base, our knowledge of rigid airship operation was largely yet to be gained and in the absence of this proper operating knowledge, naturally other factors, strategical and economical, ruled the selection of a site. Lakehurst was intended largely as an airship construction and experimental station, but it happens that as an airship operating base, Lakehurst is rather unsuitable. Bear in mind the distinction between an airship operating base and an airship construction station; for the latter purpose Lakehurst can be said to be fairly satisfactory. But Lakehurst is handicapped by being in the path of practically every trans-continental and Canadian border atmospheric disturbance and feels some effect from most passing tropical storms as well as from many secondary barometric depressions that form off-shore and move up the Atlantic Coast. The resulting percentages of undesirable and dangerous handling and flying weather, i.e., of unsuitable airship terminal weather, as viewed from our past and present needs, are therefore high. For the reason that one airship base can be more suitable than another, for proximity to the fleet and for other reasons, I feel that if an airship operating base on the Pacific Coast in any one of a number of sites in the vicinity of the fleet base had been an actuality for the same period that we have struggled at Lakehurst, airships would very likely by this time have logically become units of the fleet of at least as great importance as airplanes and perhaps greater; or, we certainly could have determined during such a period whether the airship project is or is not of value to the fleet.

Perhaps such statements may seem to be incriminating the airship on the subject of its dependence on weather. We have to learn to walk before we can run and our airship missions have been largely involved with experimental and training work where very serious risks could not be afforded as a general thing. When flying problems are to be solved, actual flying is generally required, and where the weather often makes experimental flights inadvisable, the natural consequence is that favorable chances are awaited and time passes. This unfavorability is felt very much more in ground handling considerations than in actual flying, and there were certain other more urgent problems of flying and training to be solved before new handling problems could be tackled, for it must be remembered that our nucleus airship personnel was indeed small and long without definite personnel policy and thus subject to considerable turn-over.

Regardless of the peacefulness of the elements at the take-off point, once in the air there is nearly anywhere always a wide choice of conditions within easy reach to which to subject airships in learning to fly them and for testing them in other than ideal situations. But of course, Lakehurst has some good points; we now have there a fair sized layout and we shall continue to do our best there and to make progress against the natural odds; and although our early flying has been impeded, these very disadvantages of Lakehurst may actually have expedited the attainment of suitable auxiliaries.

(*c*) *Undeveloped Handling Methods:* A number of flights have suffered postponement and even abandonment because of our inability to handle ships in and out of hangars under any but comparatively good conditions. Likewise, difficulties have been experienced in the past, in landing a statically "light" or buoyant ship under certain conditions without releasing lifting gas. Improved water recovery and the utilization of the mooring mast have proven of considerable value in overcoming these obstacles, but the mooring mast in its present development is not a cure-all for our mooring problems nor has it assumed its final form. It must be borne in mind also, that in the compromise between weight and strength, all rigid airships at present in existence, as well as those of the past, were designed and constructed with flying qualities and considerations predominant, whereas handling was left a secondary matter. We are certain that future design can and must yield more to handling considerations.

The present tall mooring mast has served as an important link in the transition period of airships; but, unfortunately, it has limitations. The most serious drawback to the high mast is the danger to the moored ship from vertical air currents. The common conception of wind is that of a mere horizontal flow of air and were this idea always true, flying would be comparatively simple. It so happens, however, that the atmosphere abounds in waves and in vertical currents of air as well as in the common horizontal flow. Squalls and thunderstorms we know are accompanied by vertical currents and, although airships have ridden out storms while moored to a mast, it becomes a matter of serious consideration when one thinks of what might be the result in extreme cases when the ship riding normally at a high mast with only her nose secured, has the stern lifted violently upward or perhaps forced violently downward together with rapid change in azimuth. Lightning and precipitation are not so much to be feared. It is my opinion that the proper place for mooring out a ship is at or very near the ground in the currents of lower velocity, where the nose may be held in an arrangement which will give perfect freedom to answer the wind and where the stern may be controlled vertically, yet given freedom horizontally to travel over the ground. But before this idea can be executed, it has been necessary to obtain a great deal of data on the strength and directional variations of gusts in order to determine whether the loads imposed would be within the safe limits of the ship's structure. This meteorological data was not already available and required specially designed instruments for obtaining it. Although the structure and other characteristics of gusts have not yet been accurately analyzed, there is sufficiently great promise already indicated to warrant proceeding with the application of this mooring scheme.

The ground problems of airships, outside of mooring, involve in general terms: (*a*) the landing of ships from flight and (*b*) the moving or handling of the ships over the ground and in and out of hangars. Our manual handling and landing methods are to a large extent based on those passed down to us from German practice where an abundance of man power was always available. The present method of landing a ship from flight at a mast with a crew of a dozen men and mechanical aid, when applied to ground landings will, we believe, eventually replace a large number of the men necessary to pull the ship down manually with the lines now carried for that sole purpose. The problem of moving the ship in and out of a hangar is not so simple. It might be said in this connection, that insufficient thought in this country has heretofore been given to the elimination of eddy disturbances and the like around a large hangar by modification of the hangar design itself. We now know that it will be necessary to run wind-tunnel experiments with hangar models to assist in solving handling problems. Also, there have been submitted several ideas that

promise to result in making possible large revolving hangars, so that ships may be handled in and out under the comparatively easy conditions of a parallel wind rather than in the more difficult case of cross hangar winds.

Even though the substitution of mechanical power on our present ships in place of the very flexible man power used in handling them over the ground has been a perplexing problem, we have found it will not be necessary to provide ships that will stand handling into hangars under unlimited conditions or gear capable of serving under extreme conditions, for a study of records has shown that even at Lakehurst on ninety-six per cent of the days of the year the wind drops to less than twenty miles per hour velocity for periods of two hours or more. We are now engaged in the assembly of equipment which we believe will be a great step in the direction of the general substitution of mechanical power for a large part of the man power. More recently, we have become engaged on a project which goes even farther and coördinates the problems of landing, mooring and mechanical handling in a comparatively simple mechanical contrivance. The details of this I cannot go into at this time, but the whole project does not appear to be extremely involved, expensive, or difficult of production. Of course, we must feel our way step by step, but the period before realization should not be long if we are allowed to continue with experimentation.

I believe that when the landing, mooring out and handling problems are correctly solved and the large ground crews accordingly reduced, the moment has arrived when commercial enterprise can then, if ever, safely step in to the operation of rigid airships. There will always be other features that require development and refinement, but they are of such a nature that I believe their overhead can be readily absorbed.

(*d*) *Helium Situation:* It is generally recognized, of course, that economy in peace time is not only always in order but in Government circles is mandatory even in experimental work, and where economy reigns, rapid results are generally not to be had. Nowhere is man so helpless without an abundant supply of the necessities peculiar to his endeavor as in aërial operations and when reserves get below an established minimum it is usually only foolhardy to attempt continuation of operations until forcibly stopped. Scarcity of our above-ground helium supply and the consequent necessity of conserving our operating supply has, at times, restricted airship operation. An airship subjected to the severe weather of the United States which often continues for long stretches, without an available replenishing supply of lifting gas, may find herself in a serious predicament. On several occasions our reserve operating supply of helium has dwindled to nothing and, coupled with certain other avoidable material conditions, has forced the *Los Angeles* out of operation. Born under war time conditions and necessarily of a pioneering nature, our original helium project has proven of entirely insufficient scope for even our peace time needs; not because of any major difficulties but rather because of actually small ones easily capable of remedy.

The sole source of helium in the United States at present is the U. S. Helium Production Plant now operated by the Bureau of Mines at Fort Worth, Texas. The output is divided equally between the Army and the Navy. The full capacity of this plant is about 3,000,000 cubic feet per month, this being dependent on the helium content and the quantity of helium bearing natural gas supplied the plant; but the actual output has been only from about one-third to one-sixth of the capacity. Naturally the overhead costs remain about constant so that when the natural gas supply falls off, the cost of helium goes up. The cheapest helium we have attained with present methods is about $24 per thousand cubic feet (achieved when under navy management) and when we compare this price and the repurification feasibility of helium with the cost of hydrogen, the advantage goes to helium. Our helium experts estimate that with equipment of known new design running at full capacity, the cost of helium can be reduced to $15 a thousand certainly and very probably to $10. The United States is committed to a helium inflation policy and it is interesting to note the high regard of other nations for this safer buoyant medium even though it has a lower lifting power. Dr. Hugo Eckener, president of the Zeppelin Company, has stated that his company would use helium were it available to them. An article appearing recently in the Japan-

ese press states that the discovery of helium of excellent quality and capable of quantity production has rewarded the efforts of their naval authorities in the search for this gas. For several years Canadian helium bearing locations have been the subject of investigation and recent reports indicate that "deposits" of moderate helium content are available in Canada. Frequent reports from Europe indicate that chemists are striving for "synthetic" helium.

The last Congress provided an appropriation of $1,063,000 for expansion and development of the helium project. The results of this are yet in the future but it will allow continuation of the work necessary to produce cheap helium. Also, only a few months ago private capital entered the field of helium production and, with the cutting of red tape surrounding government contracts and economy methods, the real issue of producing helium cheaply should very soon be achieved. Private enterprise in the helium field is certainly necessary before commercial operation of airships becomes feasible.

Past and present airship operations have felt and now feel the shortage of an operating supply of helium. The advantageous competitive results that might have been obtained from simultaneous operation of the *Shenandoah* and the *Los Angeles* were lost because we could not have both ships inflated at the same time. The *Shenandoah* wreck cost us what then seemed a considerable quantity of helium and the natural deterioration of the German built *Los Angeles* gas cells contributed to the loss of a bit more. Also, before the attainment of satisfactory water-recovery apparatus, it was at times necessary to reduce the buoyancy of the ship after long flights by releasing helium. However, in the last year on only one ocasion has helium been purposely valved from the *Los Angeles*. Sometimes the rain load taken up by an airship may, when finally eliminated, leave the ship with excess buoyancy, perhaps necessitating the valving of helium. Were helium abundant and less costly, both of which it could easily be made, rain would be considered merely unpleasant or uncomfortable. Likewise, the airship captain who could feel free to reduce possible excess buoyancy of his ship by releasing helium on the rare occasions when it becomes absolutely necessary, could increase the number of flying hours of his ship. He would feel that in taking off in flight and in landing at times other than those of maximum and minimum superheat, he was not jeopardizing the morrow's operation of his ship should today's operation necessitate valving helium.

Water recovery apparatus is now fairly well developed and has saved a great deal of helium in its collection of water from the engine exhaust to counterbalance the weight of the gasoline consumed. However, to take care of the possibilities of operation under all conditions, a small allowance for loss of helium for valving must always be made. On a recent flight of the *Los Angeles* to Pensacola and return, the saving in helium attributable to the actual 110 per cent efficient performance (by weight) of the water recovery apparatus paid for the apparatus several fold at the average price of helium, and even if hydrogen had been used the saving would have been enormous.

(*e*) *Importance of Missions:* The relative importance of missions assigned our airships has always entered into the decisions of those concerned in operation, particularly because of having only one ship as pointed out under "lack of airships." Knowing the past shortcomings of handling methods, for example, it would be foolish to take a chance or to try to stretch known safe limits to accomplish a flight of no great immediate importance. The majority of flights foregone or postponed in peace time could, even with present facilities and larger ground crews, have been performed had war or other urgent considerations made them mandatory or even merely desirable. Flights for keeping our citizens visually informed of progress made are of course desirable and can be incorporated with flights for other more serious purposes. It is now highly desirable that we omit the longer flights easily within the *Los Angeles*' capabilities and concentrate on training and on the mooring, handling and navigational problems. After a certain amount of theoretical preparation, advancement is made largely by "trial and error" methods and we should not encumber our one airship with missions not of importance to the ship itself. This is now our policy but earlier we may have tended towards the longer and hence more spectacular flights and frequently the flying qualities of airships were doubted and criticized because on a number of occasions the importance of the

scheduled flights did not warrant the handling risks necessary to accomplish them. It might be pointed out that airplanes also had a similar stage to pass through in attaining their present usefulness. In fact, veteran airplane pilots can tell you of the early days when the test of conditions for flying consisted in throwing a handful of fine sand into the air; if the sand took any direction but straight down, conditions were considered unfit for flying. Comparatively, airships are well beyond this "sand" stage however.

(*f*) *Weather Service:* Heretofore, man's ordinary routine of life has found two daily weather maps sufficient. For years, the Weather Bureau, twice daily, has collected meteorological readings from a large number of stations scattered over the United States and certain possessions, and parts of Canada. Utilizing these readings, synoptic charts are constructed from which the forecasts are made. With the means and funds available, the Weather Bureau has done wonders, but the speeding up of life by the present and promised prevalence of flying and aërial transportation makes the present weather service inadequate, at least for flying needs.

In flying, one changes his location so rapidly that he may be continuously running into new weather conditions, and aircraft in flight thus require frequent weather data. Not only is it necessary to have knowledge of dangerous weather conditions so that they may be avoided, but it is equally important to be able to take the maximum advantage of favorable and beneficial conditions. For years, the British have had available four daily weather maps, and there is no doubt that some day we must increase the number of our daily maps.

Until recently we obtained for forecasting purposes only data at the earth's surface. There are numerous times when the predictions from our surface data fail to materialize or are realized with unexpected variations. It therefore follows that we surely lack certain elements of information in predicting weather and it is very likely that the upper air data should be considered among these. There are now in existence about three dozen stations equipped for obtaining upper air data, and those concerned are correlating this data with that from the surface in the effort to solve the vagaries of weather. We do know, for example, that when the *Shenandoah* was destroyed by a storm in Ohio in September, 1925, if we had had knowledge of an upper air current of cold air pouring in from the Northwest at some 6,000 feet, the highly probable formation of such squally and stormy weather could have been predicted for the location where the *Shenandoah* came to grief. Upper air data may not be the all-sufficient means that is lacking, but it is now considered a highly probable source of valuable information.

To make trans-oceanic flying common and safe, as it will be in a few years, we must duplicate for the ocean expanse what we have been doing in the way of weather information for *terra firma.* For special flights, the Weather Bureau has obtained readings from the numerous ships at sea and drawn the necessary maps. However, although this service would be, even under ordinary conditions, of inestimable value, even for surface craft, lack of funds has made it impossible to render this great public aid. Some day we shall come to the realization of this world weather service as a means towards securing greater friendliness and coöperation amongst nations as well as being of greater benefit to the air and surface sailors of all nations.

(*g*) *Miscellaneous:* The successful construction and operation of the *Shenandoah* contributed considerably to the cause of airships, but her loss checked outside enthusiasm for the moment and threw upon the almost unassisted *Los Angeles* the burden of keeping airships before the world, and of keeping experimental and research work alive. Certain material factors have made this a real task and require a brief explanation. The materials available to the Germans, immediately following the war, were not all of the highest grade. To this can partly be ascribed the wearing out of the *Los Angeles'* gas cells and the consequent high rates of helium loss. The search for substitute gas cell material has been a slow one and funds were only recently available for new cells. The natural disintegration of material after about four years, and the lack of helium have therefore repeatedly interrupted operations of the *Los Angeles.*

During the war, the largest and most successful airship engine was a 260 h.p. Maybach. The 400 h.p. Maybach engine was a new development for the *Los Angeles* and naturally required time to perfect. Even

though the delivery of the *Los Angeles* was delayed about a year, not all the engine troubles were eliminated and some loss of operation has resulted. Meanwhile, the Germans have worked over this engine until their connecting rod and main bearing troubles are said to be entirely eradicated and 530 h.p. is now obtainable from the same engine. With these modifications now being made, the *Los Angeles* power plants will soon be unexcelled.

It might now be interesting to glance briefly at some of the promises the future holds out for airship design and construction in addition to the remedying of the situations outlined above.

With increased dimensions, the volume of an airship, and hence its lift, increases as the cube of the lineal dimensions, whereas, in general, the cross-sectional area, and hence the head-resistance, increases only as the square of the diameter, so that the general efficiency increases with size. Also, up to very large sizes, the increase in structural weight is less than directly proportional to the increase in size. This is due primarily to the ability to use larger individual structural members.

As you no doubt have seen from pictures, early rigid airship structures made use of a parallel body section. This practice obtained generally, even down to and including the *Shenandoah*, and resulted largely from the influence of the earlier German necessity for turning out airships rapidly in quantity production. The modern tendency is toward the short and fatter type represented by the *Los Angeles*. Her volume is 2,600,000 cubic feet, her length 656 feet and her maximum diameter 90 feet; whereas, the *Shenandoah* had a length of 680 feet but a gas volume of only 2,150,000 cubic feet and a maximum diameter of 78 feet. The fineness ratio (or the length divided by the maximum diameter) for the *Shenandoah* was about 8.7 whereas the later *Los Angeles*' ratio is but about 7.25. Ships now being built contemplate a fineness ratio as low as 5 to 1 in the proven Zeppelin type and in the ultra-radical departure of the experimental so-called "metalclad" as low as 3 to 1. The shorter, fatter construction gives a stronger ship for the same weight of structure but has slight disadvantages. Stability and maneuverability are so interrelated that an increase in one generally means a decrease in the other. The fat ship possesses decreased stability and increased maneuverability over the longer, slender type, which may be explained by stating that the fat ship will feel the atmospheric instability and respond to it more quickly than the slender ship, but, by the same tokens, she will respond more quickly to her controls in overcoming such conditions. Operating personnel favor the ship of the greater fineness ratio whereas the constructor inclines to stress the greater strength and efficiency of the fatter ship, and, just as in many other construction features, the resultant must be a compromise. Our new ships will probably have a fineness ratio of about 6 to 1, influenced somewhat by the necessity for erecting a ship of a certain volume in a hangar of fixed dimensions. British new ships contemplate a fineness ratio of about 5 to 1. However, the desirability of going to the extreme fineness ratio of the metalclad is yet to be proved.

One of the salient features of airships over other types of aircraft is the multiplicity of safety features such as: their ability to remain aloft in spite of power plant failures; large number of power plants; large number of compartments for the lifting medium; accessibility for repair in flight, etc. New construction will emphasize a number of these safety measures even more than in the past. For example, in present types, there has been but one corridor or reenforced passageway in the ship. The larger ship will permit as many as three or four longitudinal corridors that in reality will add greatly to longitudinal strength. The ability of such a ship to resist forces similar to those which broke the *Shenandoah* is greatly increased. The larger, deeper girder members of ships of the prospective sizes add materially to the facility with which inspections may be carried out during flight around the complete periphery of the gas cells.

Increased structural strength will permit of increased speed. It has long been realized that increased speed is one of the airship's greatest aids against the elements and this becomes possible in larger ships. With greater strength and greater speed, the airship should be gradually winning the battle against the forces of nature.

The use of helium as the inflation medium points to the feasibility of reducing the total resistance by the installation of

power units inside the airship hull and driving the propellers through shafting. This, in turn, brings us to the desirability of furnishing additional safety by the substitution of heavy oil engines for gasoline engines. The British are working seriously on this type of engine for their hydrogen ships, but we in this country have made less progress in such engine development. For the present the British may use kerosene in airship engines for added safety, utilizing the hydrogen of inflation as an auxiliary fuel.

To avoid one possible source of loss of helium, it is customary on all flights not demanding the maximum performance of the ship, to inflate the cells to less than 100 per cent fulness. This enables the ship to attain a certain altitude without loss of gas. In this connection it should be understood that as the ship rises into the rarer atmosphere, the helium under this reduced air pressure expands within the unfilled cells until at some altitude the cells become totally full. Any further increase in altitude will result in the further expansion being taken care of by exhaustion of helium into the atmosphere through the gas-cell automatic valves. For example, under average conditions, a ship inflated to 85 per cent fulness at sea level can attain an altitude of about 5,000 feet without loss of lifting gas. This means that the remaining 15 per cent gas cell space was empty at sea level. There are a number of gases of the methane series which possess high thermal efficiency and are readily combustible in gasoline engines. These gases vary in density from that of air to considerably lighter than air. If we, therefore, fill some of the unused lifting gas space with a fuel gas lighter than air, we not only acquire additional lift but added fuel as well. Also, if it becomes necessary to reach an altitude at which gas volume must be expelled or to reduce buoyancy purposely, the cheaper and more abundant fuel gas can be allowed to escape instead of the helium.

The possibilities can readily be appreciated and it is estimated that 25 per cent can be easily added to the performance of a helium-inflated ship by utilizing a gaseous fuel. There is, of course, added danger due to the inflammability of such a fuel, but when all is considered there is probably not much more hazard than already exists from gasoline vapor. Certain structural changes as well as gas cell modifications must be met in such a project, but, in a ship designed for this system, it is felt that the installation can be readily acomplished without serious complication.

There are other interesting problems in connection with airship power plants. The very low-weight, high-powered, air-cooled engines catch one's eye at once as possible weight savers. However, the situation in airships is different from that in airplanes where there is always a sufficient cooling airstream when the engine is in operation. In airships, it is necessary to maneuver just as in surface ships with engines ahead and astern. It is also necessary to have idling periods when the propellers are not turning over. The substitution of air-cooled engines for all the water-cooled engines of an airship in their present status is therefore impracticable. However, when a ship is large enough to carry as many as six power plants, it may prove desirable that two of these be of air-cooled design to be used at high speeds only.

Starting and reversing features are always of interest in airship engines. These have been ingeniously solved in the German Maybach engines of the *Los Angeles* by the use of compressed air and the reversal of direction of rotation of the engine itself. Much effort has been expended in this country on reversible pitch propellers but we yet lack a rugged satisfactory product. The weight of gearing for ordinary reversing methods generally runs quite high.

Another engine problem of interest is that of securing vertical thrust from airship power plants. The benefits of such an arrangement are of great order. An airship might take off with greater loads than her buoyancy alone would provide for; and a very "light" or excessively buoyant ship might be landed without releasing a portion of her lifting medium.

The construction of gas cells is of great interest and possibility. The most successful cell yet devised consists of a high grade cotton fabric made highly impervious to gas passage by the cementing of goldbeater's skins to it. These skins are portions of intestines of oxen and are of small size so that the labor of applying them to the fabric has been one of the most costly items of gas cell manufacture. A number of substitutes have been tried, several of them producing equal and even better gas-tightness than goldbeater's skins, but lacking the abil-

ity to stand the necessary packing and handling. One of the most promising substitutes for the goldbeater's skins is called "cellophane," and resembles very much the transparent material used to keep candy boxes airtight. As we all know, this material is easily torn, and, once wrinkled, is spoiled. Much effort has been expended towards making it more durable as this material has a very low diffusion rate, is comparatively cheap and can be applied by rolling on in sheets. Another very promising material of similar nature and properties is called "viscose latex." We expect to obtain a suitable answer from one or both of these substitutes which will reduce the cost of gas cells at least one-half, besides expediting manufacture.

It would not do to pass over the subject of superheat and its effect on airship operation. Perhaps you have noticed that if your closed car stood in the sun during the day, you found, upon opening it up, that the inside air was noticeably warmer than the outside air. This difference of temperature is similar to a "superheat" condition we have in airships when the gas temperature and that of the surrounding air are different. During the day, the enclosed gas in the cells absorbs heat and becomes of higher temperature than the air; during the night the gas becomes cooler. In passing through strata of air of different temperatures the gas does not immediately adjust itself to the new temperature and the superheat condition may fluctuate. In flight, of course, the differences in buoyancy resulting from changes in superheat are generally taken care of dynamically.

Superheat can be utilized, when the nature of the mission of the flight will permit, to save the lifting medium and in our operation with scant helium supply we have made great use of it. If, in preparation for flight, the ship lies at the mast or on the ground (her cells as customary less than 100 per cent full) absorbing heat from the sun, she will, during sunlight, attain a superheated condition of the helium. This results in a decreased density and increased volume of the helium so that additional buoyancy or lift is obtained and more load can be carried. During the night, in a closed hangar, the temperature drop lags behind that of the outside air; by rushing the ship out and taking the air at once before temperature equalization takes place, it is practicable to get off with fair superheat. By taking off with superheat and landing after the sun's heat begins to wane, the ship can land without having any excess buoyancy to overcome by releasing helium. In our training and experimental flights we resort to this practice as much as possible and much helium has thereby been saved. On cloudy days or out of the hangar at night, we may not obtain the desired superheat, naturally, and this has given rise to the project of obtaining artificial superheat. A superheat of five degrees Fahrenheit gives an additional buoyancy of about 1 per cent of the total lift of the ship and, as generally only 2 to 2½ per cent "false" lift is desirable, a means of providing only ten to twelve degrees Fahrenheit superheat becomes the problem. Investigations show that this is probably easy of accomplishment and we look to this as one of the advancements held by the near future.

The substitution of magnesium alloys for those of aluminum is another phase of interest in airship development. It is known that magnesium alloys in comparison with duralumin can be produced to give greater strength for the same weight or the same strength for less weight. Should this become practicable in airships, the increased efficiency is at once apparent. However, the corrosion problems are those yet to be solved, but when they have been, we may expect a more efficient material for aircraft structural purposes.

No weapon which has a possible use in war should be neglected and unless we labor and experiment on all possible weapons during peace, our war time efforts may be faulty and of reduced value.

Lack of space prevents discussion of other interesting features, but it is hoped that the reader has been able to gather from this article an idea of airship problems with which we have been confronted.

Interrelations *of* Sea *and* Air Problems

By the HONORABLE EDWARD P. WARNER, *Assistant Secretary of the Navy for Aëronautics*

(EDITOR'S NOTE: The following is the substance of an address delivered at the Naval Academy, May 23, 1927, preparatory to the beginning of the Summer Aviation Course.)

THE qualifications of a seaman have always been much diversified. To speak in praise of seamanship has always been to imply the possession of a long list of widely varied attainments. Since the day when Phœnician galleys began to stretch their coasting voyages beyond friendly boundaries, and even to fare out into the open ocean, the vessel at sea has been a little principality, the lives of its inhabitants dependent upon their ability to display a total self-sufficiency. When gear broke, officers and crew must repair it. When need unforeseen arose for new equipment, it must be improvised from material at hand. When disease appeared it must be cured, if at all, by remedies carried on board and by the medical skill of some member of the ship's company.

With the change from oars to sails and from sail to steam there have been corresponding changes in the demands upon the men who go to sea. A few of the arts and handicrafts, of which it was important to have knowledge a hundred or a thousand years ago, have fallen into disuse, but for every one that has lost its importance a dozen more have come to take the vacant place. Seamanship, navigation, gunnery and engineering have spread out into innumerable ramifications of increasing complexity, and the problem of this institution, like the problem of the technical school for civilian students, but in an even greater degree, becomes one of difficulty, if not of sheer impossibility, of covering within the space of four brief years even the most essential parts of the most essential subjects. Those subjects have not only to be taught individually, but at the same time to be so coördinated as to give a fair idea of their inter-relationships and their inter-dependencies not presented as so many branches of knowledge each packed in its own little water-tight compartment. The scope of the naval profession expands indefinitely, and the obligation on every officer to know something of aircraft, of their mode of operation, and of their potentialities is but the most recent addition to a formidably long line of technical subjects to be scanned and dipped into though all cannot be thoroughly mastered by any one human being.

Through all these changes there runs one fundamental motif. Basically, the evolution of naval equipment and of naval operations, as effected by the equipment through the century which leads from "Old Ironsides" to the newest craft of the new Navy, has been a transition from art to science; a supersession of rule of thumb by research; a giving way of the skilled craftsman before the scientifically trained engineer as the dominant element in the making of a plan. Navies, like industries, have undergone in the last century a revolution so gradual and peaceful as hardly to be recognized as such.

A readjustment so profound in the whole structure of naval affairs has brought correspondingly sweeping revisions in principles and practices of professional education, and it has exacted such modifications of mental attitude during its course as to give every temptation to the adoption of an extreme point of view, an extreme of conservatism or radicalism; an extreme of optimism or of pessimism about the advantages to be gained from novelties, depending on the character of the individual.

Most of us have a natural tendency one way or the other. Most of us have a predisposition, against which we must struggle, either to resist change because it is change, or to welcome change for its own

sake with open arms, and the middle ground of discrimination between the new development of inherent promise and that of dubious merit or none at all, neither expecting miracles nor belittling novelty as such, offers a straight and narrow path to follow. The reluctance to accept anything new, which was responsible for so many dubious expressions about the future of railroads in their early days, and so many confident assertions that steam could never replace sail in naval vessels, can be counterbalanced in the records of the past by waves of enthusiasm which have acclaimed various fads of the hour as destined to bring about revolutions which in fact never materialized. The unbridled sway of one extreme point of view would have left us as cavemen to this hour, and the unchecked dominance of the other would have entailed a substitution of a perpetuity of chaotic experiment for orderly and systematic development.

Aviation, in the Navy and elsewhere, has had its full share of suffering from the attention of the extremists, both from those who persistently refused to see anything in it and from those more cheerful, if no more enlightened, spirits, who have declined to set any bounds whatever to the capabilities of aircraft. Despite alike the perilous pessimism of the one and the dangerous overenthusiastic claims of the other, the airplane and airship have made their way to a steadily more important service and more general recognition both in and out of the Navy. It is fortunate that we are now able to feel that sanity has triumphed, and that reasoned analysis of fact, which the engineer and the naval officer habitually apply to their problems ashore or afloat, has supplanted emotional reaction in dealing with the potentialities of aircraft and in adapting them where and as they can be of most service.

When the general place of the airplane in the naval service is considered, in anticipation of an analysis of the scope of activity permitted to it by the existing state of the aëronautical engineering art, it develops that all its functions can be concentrated under a single head. It is occasion for remark as a signal curiosity that although the airplane is characteristically a short-range vehicle, its radius of action being insignificant as compared with that of many surface vessels, its uses in the Navy all bear upon the increase of effective range of action or upon the ability to exert naval power in some form at a distance greater than that hitherto possible. We tend to think of high speed as the machine's outstanding characteristic, and high speed is supremely important in the accomplishment of many of its missions, yet the final and fundamental utility of the airplane rests on expanding the range of operations rather than on a reduction of the time required to carry them out. Range of vision in scouting of a vessel equipped with a reasonable number of aircraft has been increased to fifty or a hundred miles or more. Range of vision in fire control has been so expanded that the fall of shells at 30,000 yards can be observed almost as minutely as the impact of solid shot in the days when battle ranges were under half a mile. Range of anti-aircraft defense is increased to 20,000 feet or more vertically, and to many miles horizontally, by the availability of fighting planes to be launched forth in anticipation of the coming of an enemy. Finally, and perhaps most important of all, the range of fire from a surface ship has, by virtue of the coming of the bombing airplane, risen from a maximum of 30,000 yards or a little more to something of the order of 100,000. The aircraft-carrying ship is a fighting vessel, even though it never mounts or fires a gun. The only difference between that craft and a battleship carrying high elevation guns is that, whereas the battleship may elect to maintain a range of 30,000 yards during an action with an enemy vessel of lower power and smaller gun elevation, the aircraft carrier similarly may choose to fight at 50,000 yards or 60,000 as its most effective range, given the speed to enable it to maintain the distance that it chooses.

Such expansion of possible range of action necessarily modifies the details of strategy and tactics. It has been an axiom of the science of military operation from time immemorial that new equipment and new discoveries never change the fundamental principles, but do alter the mode of their application. Twentieth century writers on strategy can still extract lessons and choose examples from the campaigns of Hannibal and Alexander and their naval contemporaries. Neither the coming of steam and steel and the torpedo afloat, of motor transport and the tank ashore, nor of airplane and airship aloft, have made

such examples invalid, but they are useful as suggestive guides in observing the universal adherence of great commanders to universal principles, not for direct imitation in a changed era. Where change in detail of equipment occurs, furthermore, its repercussions upon operations become far reaching, for the creation of a new weapon or a new method of attack reacts forcibly upon all those previously existing, so that the efficient officer must be apprised of the capabilities of all the instruments that may be introduced into naval battle. That is another and a longer way of saying with proof what Admiral Mahan said epigrammatically in his declaration that a naval officer should have a general knowledge of all parts of his profession, with a specialized knowledge of one.

This is not the place nor the time to analyze in intimate detail the possible measure of improvement in the performance of airplanes. Detailed information is not wanting for your examination as the opportunity presents itself, but let me speak here rather in terms of broad and general principles. It is the easier to do so because of the many factors of analogy that exist between naval and aëronautical construction and engineering, and because of the consequent facility with which one trained in meeting the questions that arise in marine engineering can put himself in sympathetic accord with the aëronautical engineer in his attack upon the special problems by which one is confronted in that field.

Airplane and naval vessels alike move in fluids, and both alike are subject to resistances which cannot be theoretically treated as a whole, but can only be determined by direct experiment interpreted and extended in the light of such theory as does exist. Airplane and surface vessels alike are driven by fluid reaction engendered by the use of a screw propeller. Both alike exact constant care on the part of the designer to insure adequate stability in motion through a troubled medium, and betweeen the submarine and the airship, to be specific, the theories of stability and control are so fully interchangeable and the conditions so exactly analogous that tests for the purpose of securing submarine design data have been made on models suspended in the moving air current in a laboratory created for aëronautical studies alone.

The interaction between the theories and practices of design of marine and aërial craft has carried mutual benefit. The designer of airplanes has leaned heavily upon the naval constructor at many rough places in the road, and the present state of the seaplane and flying boat and their performances are owing very largely to work done by members of the naval establishment in the Washington model basin and elsewhere, both in the laboratory and in the field. The engineering experience possessed by naval officers has enabled them not only to operate intelligently and for maximum result the aircraft with which they were furnished, but also by careful observation and shrewd deduction in the course of their operating experience, to make that experience react favorably upon future design.

The debt has, however, been by no means a one-sided one. The airplane has brought its contributions to naval engineering, and the introduction of aircraft into the naval service had made its effects felt elsewhere than in the domains of tactics and strategy. As one concrete example, the theories of fluid friction have received a vastly increased attention from mathematicians and from laboratories in the last two decades because of their importance in aëronautics, yet the results obtained are applicable in air and water alike. As another instance, the theory of propulsion by a screw is basically the same in aircraft and in surface vessels, although with certain modifying factors in each case which do not appear in the other, and new theories evolved and new methods put into use with primary reference to the airplane have proven frequently suggestive to, and sometimes directly applicable in, the work of the marine engineer. The Society of Naval Engineers has in fact recently presented its gold medal for a paper on propulsion which is based essentially on the work of students of mathematical aërodynamics. Remark may be made too, while on the subject of propulsion, of the fact that the freshest of novelties in the driving of ships, the Flettner rotor, is purely aërodynamic in its conception.

All these, however, are matters of detail, and there is a much more fundamental relationship between naval and aëronautical engineering. It lies in the fact that both alike are subject to the severest limitations

of weight and space. In a stationary power plant ashore neither the weight per horsepower nor the number of cubic feet occupied by engines and their accessories are of direct importance except as they may affect the cost. On a vessel afloat they are matters of the most vital concern, and especially is that true on high-speed naval vessels where 100,000 horsepower must be packed within a space which could readily be devoted to one five-hundredth part of that power without leaving any impression of prodigality or waste. The importance of weight in aircraft needs no emphasis, and dimensions become important for their own sake, particularly in the naval service, where the number of airplanes that can go to sea on a vessel is necessarily inversely proportional to the amount of space occupied by the individual machine.

The naval engineer and the airplane designer thus have their shoulders to the same wheel, each engaged in a struggle for ounces and inches, and they can profit by watching each other. Particularly can the naval engineer profit, for in the airplane that struggle takes a form even more extreme than in the ship, and it is often of advantage in dealing with a problem to observe the experiences of some one else to whom it is presenting itself in somewhat similar but intensified form. The degree of that intensification is suggested in economic terms when it is declared that, whereas the saving of weight has an effective cash value in reduced costs of operation during the life of the unit, of only ten or twenty cents a pound in a railroad car or merchant vessel, the corresponding figure rises to something of the order of twenty dollars a pound in a commercial plane. In other words, from a cold-bloodedly material point of view, if the long view extending over the entire life of the equipment be taken, it is profitable to assume an increase of twenty dollars in cost to save a pound in weight of structure. Everything else being equal, it would be worth while to replace twenty pounds of material costing ten cents a pound with nineteen pounds of a more precious metal at a dollar and ten cents per unit. There remains small ground for wonder that the development of aircraft has focused attention, as nothing else would have been likely to do, upon the development of light alloys and other materials presenting a high strength-weight ratio and upon their formation into special shapes and the assembly of these shapes into complete structures by the most refined methods. The results of all that effort are being felt with increasing force in other fields of engineering and industry, and nowhere do they deserve more attention than in naval engineering, where again the trimming of cost is of very secondary importance as compared with the attainment of a maximum of efficiency.

The airplane also possesses special advantages as a vehicle of engineering experiment in that its life is so comparatively short that the turn-over is rapid, and the opportunity for the introduction of new design correspondingly frequent. Even aside from the fact that the units are small and relatively cheap, at least as compared with surface or submarine craft, their average life of some five years, as compared with the much longer existence of naval vessels, is in itself a stimulant to that experiment which leads to progress. When new units have to be bought at the rate of several hundred per year, it is manifestly both desirable and feasible to try out more new ideas than when only two or three purchases are to be made per annum.

There is yet another close parallel between the situation of the naval constructor and engineer and that of the constructor of aircraft, and this strikes back to the fundamental question of the possible attainments of aircraft and of their prospective capabilities in the naval service. Ship and airplane are both the fruit of compromise and of an anxious balancing of all the factors that enter into determining the desirability and efficiency of the finished product. Ship and airplane both demand the preliminary determination of a primary objective, with secondary and tertiary aims ranked in their proper places and provided for in the measure of possibility without undue disturbance of the element upon which the usefulness of the craft is focused. Admiral Mahan, driving home by repeated illustration and analogy the importance of concentration as a guiding principle of naval strategy, remarked, "The same consideration applies to ship design. You cannot have everything. If you attempt it, you will lose everything; by which I mean that in no one quality will your vessel be as efficient as if you had concentrated purpose on that one." We cannot in the surface

ship combine the highest speed with the heaviest armor and the greatest degree of protection, and it is equally true that the airplane cannot be simultaneously endowed with the highest speed, the greatest endurance, and the ability to carry heavy loads, to climb to high altitudes, and to maneuver as may be necessary in combat. The establishment of records is not necessarily an index of service efficiency, for the record-breaking machine may be quite unfitted for steady service employment. There has lain upon the operating personnel of the service in recent years the obligation of so directing their activities as to gain experience upon which decision as to the best form of compromise, and as to the degree in which one feature of performance may profitably be sacrificed in favor of another, could be based. The work done by aircraft with the fleet serves to show us what we want to do and what would be most useful, while the progress made in the science of aëronautical engineering puts our technical personnel in position to say whether or not it can be done.

The naval service has two more or less distinct functions. It has always to remain ready for instant action, whenever, wherever, and however that may be needed, never taking anything for granted. It has on the other hand, to look not only to the present, but to the future, and to insure not only readiness for the eventualities of the moment, but also progress which will keep equipment and personnel at least abreast, and preferably ahead, of any others in the world at an indefinite period ten, twenty, or fifty years hence. Neither obligation must be allowed to lapse; neither to run away from the other. Whether in surface craft or in aircraft, whether in engineering or in gunnery, the desire for experiment must not become dominant; yet, on the other hand, the laudable aim of attaining the utmost in efficiency in present operations must not lead to a slavish adherence to the best of methods so far demonstrated, and to a neglect of experiments, the purpose of which, even though there be but one success among many errors, is to lead ultimately towards something better than is now known. It is perhaps particularly true of the air arm, because of its novelty and because of the rapidity with which it was developed, but it is true in considerable measure of all branches of the naval service that the officers and men are engaged in research on a grand scale. Their problem, on which progress in naval aviation, gunnery, engineering, submarine construction, or whatever you will, must rest is one of carrying on that research without slackening in efficiency in those standardized forms of procedure which have to be employed when the Navy is called upon for action on short notice. It is their problem, as it is about to become yours, to reach for the stars without losing firm foothold on the solid rock of existing achievement.

Flight Training *of* Student Naval Aviators

By LIEUTENANT BARRETT STUDLEY, *U. S. Navy*

(See pages XLIII, XLIV, XLV and 828-830)

WITH the recently authorized expansion in the aviation strength of the Navy, there has developed an urgent need for an increase in the number of naval aviators. It is the function of the Naval Air Station at Pensacola, Florida, to supply this need. Four times a year classes of naval officers commence instruction here. The entire course of training, including advanced courses, requires approximately ten months. Those students who complete satisfactorily the prescribed work are designated naval aviators, and are then considered qualified for duty in aircraft squadrons of the fleet.

What Is a Naval Aviator? Before taking up the training of student naval aviators, it will be pertinent to ask the question, What is a naval aviator? A comprehensive system of checking is carried out to determine the relative ability of each student. What considerations prompt the decision to designate one man a naval aviator and to discontinue the training of another?

A naval aviator is both an aviator and an aviation officer. These terms as used here are by no means synonymous. The kinds of capacity required are fundamentally different and bear no definite relation to each other. A man may either be a fair aviator and an exceptionally good aviation officer, or he may be the reverse.

To understand what a competent aviator is, a fundamental distinction must first be made which is perhaps not generally recognized: Flying is not a science. It is an art. The proper manipulation of the controls of an airplane depends, not on the processes of reason, but on those of instinct. A landing cannot be figured out like a problem in mathematics. It must be learned gradually by the method of trial and error. First must come familiarization with the changing physical sensations arising from the varying motions of the plane through the air, and the comprehension of the significance of these sensations. After this there must be gradually developed an instinctive coördination between sensory organs and muscles which, in response to any sensation, will automatically produce appropriate control movements. This is known colloquially as the "feel of the air." Any necessity for the intervention of conscious reasoning processes between the perception of a sensation and the inception of the appropriate muscular movements results in what is termed "mechanical flying." The mechanical flyer is generally recognized as a potential crash. The competent and experienced pilot flies as he walks, conscious not of individual muscular movements but of the operation as an entity. He is an integral part of his plane, thinking, not in terms of control movements, but in terms of movements of the entire mechanism, himself included, as a unit. It is this degree of proficiency which the student must attain to become a naval aviator.

It will not do, however, to jump to the conclusion that anyone who can fly has thereby the necessary qualifications for a naval aviator. Mere ability to handle a plane is useless without the additional ability to carry out properly any designated mission within the functions of the unit to which he is attached. There is therefore the requirement that a naval aviator be an aviation officer. The term is here used in a sense comparable to the terms "engineer officer" or "radio officer" to indicate an officer who, in addition to the fundamental education and training which enable him to hold a commission in the line of the Navy, has received specialized training and is experienced in the field of aviation. In this is included training in aërial navigation, gunnery, bombing and radio communication, in construction and maintenance of aircraft and motors, and in all other phases of practical aviation, knowledge of which is

essential to an officer of an aircraft unit acting as an integral part of a naval force. Qualification as an aviation officer is essential for designation as a naval aviator.

In recognition of the dual nature of aviation training, the instruction organization of the Air Station is divided into the flight school and the technical schools. In the former is taught the art of flying. In the latter is taught the science of the operation of naval aircraft. (The connotation of the term "art" as used here is to be held in abeyance until further explanation, as otherwise an unjustified impression might be gained.) It is with the student's training in the flight school that this article will deal.

Dual Instruction. On arrival at the Air Station to commence aviation training, the student naval aviator is given a thorough medical examination, including a psychological examination, to determine his fitness for duty involving flying. He is then assigned to a wing and flight of the class. The two wings attend alternately the flight school and the technical schools, one wing flying in the morning while the other is engaged in technical courses. In the afternoon the wings change places. The wing which flies in the mornings of one week flies in the afternoons of the following week, and vice versa.

On reporting to the flight school, the student is given a copy of the *Flight School Manual*. The first part of this includes general information concerning flying, elementary principles of flight, types of aircraft and motors used during training, and station flight regulations and procedure. The second part is devoted to a detailed description of all maneuvers required in the flight school course, together with an explanation of the errors most commonly made by students and the safety precautions which will prevent loss of control in any maneuver. The purpose of the manual can best be described by an excerpt from the preface:

> Flying cannot be learned out of a book. Only time in the air will make a pilot, and the time required to produce a thoroughly competent and experienced pilot runs into hundreds of hours. But the student who, before getting into a plane, has a reasonably clear idea of what he is attempting to learn, will derive considerably greater profit from time in the air than one who has not. The object of this manual is therefore to make practical instruction as effective as possible. Preliminary study of the maneuvers described in subsequent pages will enable the student to apply himself to their execution with the minimum amount of misdirected effort. If he understands the theory, the practice will be that much simpler.

Each student is assigned to an instructor, who has not more than four students, two in each wing. All instructors are naval aviators of long experience in fleet aircraft squadrons. Methods of instruction have been carefully worked out from the experience of the station in the past, and have been proven effective in practice.

The *N9* type seaplane is used for elementary training. It is a comparatively slow and low-powered, two-place, single-pontoon seaplane, equipped with dual controls, or controls in each cockpit. The latter are of the Deperdussin type, consisting of a wheel mounted on a yoke, and a rudder bar. The instructor occupies the forward cockpit and the student the rear. The latter wears a "Gosport" helmet, or helmet with earphones and a voice tube leading to a mouthpiece used by the instructor. He also wears a parachute on all flights.

Instruction methods are based on the assumption that the student has no prior experience in handling the controls. This is necessary to insure a proper groundwork, particularly as brief experience in fleet planes is not found to be of any great value in a training plane. The student who has never been up before is not at any appreciable disadvantage in comparison with the one who has had a few hours in the air.

Familiarization with the plane, the course, and the general sensation of being in the air, is the first objective. To this end he is taken up for four flights of half an hour each by his instructor. After completion of these his ten hours of dual instruction are begun at the rate of one hour a day. The effect of the individual controls used separately is first demonstrated by the instructor and practiced by the student. The action of the elevators in moving the nose up and down, of the rudder in moving it right and left, and of the ailerons in banking is thus taught before the student is required to use them in combination.

The student now attempts to maintain the plane in straight and level flight. At first he will have some difficulty. But ordinarily half an hour's practice is sufficient to enable him to maintain a passably straight course. He begins also to learn the vital

necessity of maintaining flying speed, a necessity that is emphasized in every hour of his instruction until the idea "Never stall the plane," becomes instinctive with him.

Instruction in turns is next begun, and for the rest of his ten hours the student is engaged in a constant struggle with slips and skids. These are caused by any lack of proper coördination in the use of rudder and ailerons. Ability to detect and correct them promptly is vitally important, as, if of sufficient magnitude, they are likely to cause loss of control. Two or three hours are ordinarily sufficient to enable a student to turn consistently without assistance, and by the end of ten hours the average student is able to make reasonably smooth turns with a fairly constant bank.

Taking off, commenced in the second hour, does not ordinarily present any great difficulty to the student. At first he will either attempt to take off too quickly and must be prevented from stalling the plane in so doing, or he will fail to take off when flying speed is gained. But after three or four hours the average student performs this maneuver satisfactorily.

Instruction in landing is likewise begun during the second hour. It is to this maneuver that the major portion of the instructor's attention must usually be devoted, as it is at once the most difficult and the most important to learn. The full stall landing, in which the plane is allowed to lose flying speed and drop onto the water from a height of one to two feet, is the type of landing taught in the flight school, as it is the only one which can be safely used under all conditions. It is made with the throttle fully closed.

Landing instruction is as far as possible divided into successive steps so that the student may familiarize himself with the elements of a landing one by one. He is first taught to glide, later to break the glide and level off. His judgment of height is developed by an attempt to maintain level flight with the pontoon two to five feet above the water. He concentrates his attention on the elevators alone at first, while the instructor handles ailerons and rudder. When he has gained some idea of the use of the controls, he is started on what are termed here "slow motion" landings, in analogy to slow motion pictures. By leaving the motor running at approximately 1,000 r.p.m., the rate of stall of the plane is reduced and the period of the landing increased from three to five times. The student thus has time to analyze by observation the effect of his movements of the controls.

By these means the student is familiarized with the elements of a landing before he attempts to make any normal landings. Consequently he can then understand the causes of his mistakes and can apply himself intelligently to their correction. The average student satisfactorily completes a fair proportion of his landings during his sixth hour of instruction.

During his second five hours the student is instructed in spirals, or turns in a glide; in stalls, in which the plane is allowed to go temporarily out of control from loss of flying speed; and in tail spins. From brief practice in stalls and spins he becomes familiar with loss of control, how to avoid it, and how to effect recovery if it is lost.

The injunction to avoid making the same mistake twice is not applicable to flight training. The student cannot help making mistakes. It is the process by which he learns. His objective is to recognize his mistakes, to understand their causes, and to attempt steadily to decrease their magnitude.

The Solo Check. At the end of ten hours' dual work the instructor turns in a report on the student, grading him on a scale of 4.0 in taxying, turns, take-offs, landings, spirals, stunts (here including spins only), manner in emergency, aptitude for flying, and progress. At the bottom of the form is entered the recommendation, either "retain" or "drop," and any remarks. The student is now ready for his solo check.

Solo checks are given by the chief instructor and the assistant chief instructor. The decision on each student is based on two out of three reports, counting that of his own instructor as one. If the latter recommends retain, the student solos if he passes his first check. If he fails on the first one, he then takes a second, which is decisive. If the instructor recommends drop, the student may still solo by passing two checks. But if either one of them is unsatisfactory he does not solo.

This is a tense and critical time for the class. The processes of selection begin here, and inevitably some students fail to pass. Consequently rumor and speculation are rife, and all kinds of confidential "dope"

are circulated. The chief instructor's supposed preference concerning everything from steepness of turns to brands of cigarettes is considered vital information. Check planes are anxiously watched, and opinions of instructors on distant landings sought. Some of the more optimistic students will ordinarily start a score board, "Flight School *vs.* Students." The student who gets out of a plane with the injunction, "Once around the short course," is heartily congratulated and chalked up on the right side of the board. Those who fail to receive the order are commiserated with a sympathetic, "Tough luck."

Behind the excitement and the tension, the congratulations and the condolences, only the experienced pilots realize the problems and responsibilities confronting the two officers who sit in the forward cockpits of the two check planes. They never touch the controls except in emergency. They neither assist nor interfere in any way. They merely give signals—and see what happens. On what they see depend their decisions. Is he safe to solo? Has he rudimentary aptitude sufficient to indicate any reasonable possibility of development into a competent pilot? Nothing like perfection is expected—or found. But a man must be safe and must have some idea of what flying is all about if he is to solo.

The majority of checks are fairly clear-cut, one way or the other. It is the borderline cases that are difficult. If the verdict is yes, the student may go out and crack up. If it is no, a competent pilot may be lost to aviation. Those are the decisions that are hard to make.

Students who pass, go up on a five-minute flight immediately, and the next day commence regular solo flying. The others appear before informal flight boards, composed of the officer in charge of flight school and the officers who have turned in reports on them. Here the student may either be given extra instruction or his case may be referred to the advisory board. In the latter event the board, after hearing the reports and any statements by student or instructors, either allows extra instruction or recommends discontinuation of training. Reports of the board go to the Commandant for final decision.

In cases where the student's work has been nearly but not quite passable, extra instruction is ordinarily allowed. After its completion he again comes up for solo check. The decision is determined as before.

Solo Flying. With solo checks behind them the class buckles down to the work of solo flying. At first it seems a little strange. The extreme emptiness of the forward cockpit is hard to forget. Bumps in the air which seem to threaten, though they never actually cause, loss of control, occasion recurrent anxious moments. But gradually the strangeness wears off, and by the end of five hours the average student is steadily building up confidence in himself.

Weather and operating conditions permitting, one and a half hours daily is the required amount of solo flying. After completion of each five hours up to twenty-five hours the student is given a check by one of a group of four check instructors. If this check is satisfactory, he goes up for a flight with his own instructor to correct any faults exhibited on the check, and to receive instruction in new maneuvers. If the check is unsatisfactory he takes a second check and if necessary a third, each with a different instructor. A student failing on two out of three checks appears before a flight board, and if it so decides before the advisory board. Reports of all checks are made out and filed in the student's flight school record.

The standards of proficiency required on checks increase steadily with time in the air. After five hours, solo maintenance of control is sufficient for a satisfactory report. At twenty-five hours a considerably greater degree of precision is expected. Manner in emergency is also tested on this check by closing the throttle in positions where the presence of obstacles necessitates accurate judgment and quick action. Hesitation, uncertainty, or faulty execution of maneuvers must now be considered as raising serious doubts as to the student's aptitude for aviation.

After fifteen hours solo the student is instructed in reverse control, or "flipper" turns and spirals. These are turns and spirals in which the plane is banked more than forty-five degrees, so that the rudder acts principally in a vertical plane and the elevators in a horizontal plane. After twenty hours solo, instruction in stunts is given. These include the loop, split-S, precision spin and falling leaf. Their primary purpose is to accustom the student to

unusual positions of the plane and thus to give him confidence in his ability to retain or regain control of it under all circumstances. After twenty-seven hours solo he is required to demonstrate his proficiency by executing a prescribed series of stunts under observation of a check instructor on the beach. If necessary three attempts at this stunt check are allowed.

The next problem is the Pylon Test, or "shooting the boat" as it is familiarly termed. In this the student climbs to six thousand feet altitude, then spirals down to three thousand. Here he cuts the ignition switch and stops his motor completely. He is then required to make two full spirals and complete a good landing within a radius of two hundred feet from a moored boat. After instruction, three hours of solo are allowed to practice this maneuver. If necessary three official attempts are permitted.

After the Pylon Test comes five hours of formation flying, all in simple, three-plane V-formations. The final maneuvers taught are wingovers and eights. Instruction in night flying is also included at some time during the latter part of the *N9* course.

From time to time crashes occur as a result of loss of control at a low altitude. Excessive skidding in a turn or spiral, resulting in a stall, is the most usual cause. From two to six crashes ordinarily occur in each class. It is extremely rare, however, for a student to sustain anything more than a few bruises. Frequently he does not even get his feet wet. An *N9*, with its comparatively large wing span, falls slowly. Consequently the shock in striking the water is not great, and personal injury is very unusual.

After crashing, a student is sent up immediately on another short flight before any loss of confidence in himself has time to develop. The following day he is given crash checks and must pass two out of three to continue soloing.

The Final Check in N9's. After completing the prescribed work in *N9's* the student comes up for his final check in this type. This is given by the chief instructor or assistant chief instructor. Any maneuver included in the course may be required, and a thorough check is always given.

It is expected that the student will now have attained a reasonably high degree of proficiency. During earlier checks evidences of undeveloped latent aptitude may warrant a satisfactory report even when the student's actual work is indifferent. But by the time the final check has been reached he has had ample opportunity to develop whatever ability he possesses. Consequently the recommendation must now be based, not on potential aptitude, but on aptitude demonstrated by actual performance. In *N9's* a serious error in judgment or execution means at worst nothing more than a plane to be overhauled in the erecting shop. But it is not wise to send a doubtful man over to landplanes.

Accuracy and precision are expected in all elementary maneuvers—take-offs, turns, spirals and landings. These should be executed with a smoothness and steadiness that indicate an instinctive mastery of the plane. Stunts are not ordinarily given, but ability to perform wingovers and eights without stalling and without violent slips and skids is required. Initiative and judgment in any ordinary emergency, sufficient to insure the safety of at least the student himself, must be demonstrated. Proper attention must be given to all flight regulations, course rules and safety precautions. Perfection is not expected, but the results of the three months or so of past training must show concretely in the form of proved ability to handle an airplane in the air with reasonable effectiveness.

Landplanes. Landplane training is carried on in *NY-1* type training planes at Corry Field, two miles north of the city of Pensacola. Five hours of dual instruction is given, followed by a solo check. Subsequent checks are given on completion of each five hours of solo up to twenty hours. Reverse control work, stunts and formation flying are practiced as in *N9's.*

With their experience in seaplanes behind them, students do not ordinarily have any great difficulty in landplanes. Air work, except that the plane is more sensitive and maneuverable, is similar. Landings may require some practice, but two or three hours is ordinarily sufficient to acquire reasonably consistent proficiency. The principal difficulty encountered is in accommodating approaches for landings to the more restricted area available.

After completing all other work the student is instructed in cross-country flying. He "shoots" various small fields in the vicinity, and commences to develop the high degree of accuracy and precision nec-

essary to land safely in them. He also becomes acquainted with forced landings when, at altitudes of two thousand feet or so, the instructor suddenly closes the throttle and leaves it up to him to do something about it. If he expects to get down safely he must select a field within gliding distance and then maneuver the plane to make a landing in it. The instructor waits as long as possible to make the theoretical result of the student's judgment evident, then reopens the throttle. Some students develop surprising proficiency in shooting fields with a simulated "dead stick," though any instructor who is troubled with ennui, experiences a marked re-awakening of interest at this point. However, it is a very essential part of training, as the student must know how to get a plane down in case of necessity, without risk of injury to himself.

After this instruction the student goes on cross-country solo flights. The first ones are of short duration. But the final two include Pascagoula, Mississippi, and Mobile, Alabama, covering some two hundred miles each. On these the student learns to keep a proper course by observation of landmarks passed over.

A final check in *NY-1's* is given. But by the time a student has successfully passed some fifteen or eighteen checks he regards himself as more or less of a seasoned veteran and is not likely to have any trouble with it.

Service Seaplanes. Training in the *F-5-L* type flying boat was discontinued in July, 1926. The *CS* type is to be substituted. This is a three-purpose plane, adapted for either bombing, torpedo-carrrying or long distance scouting. It has a large load-carrying capacity and radius of action, and is convertible into either a seaplane or a landplane. It is unlikely that students who have completed the previous work will encounter any difficulty in flying this type.

Naval Flying a Precise Art. It was said at the beginning of this article that flying is an art. Though the construction, maintenance and operation of aircraft are subject to scientific calculation of efficiency of performance, the actual handling of the controls of an airplane in flight is the antithesis of a science. The processes of reason are far too slow to meet the exigencies of flight. Muscular responses must be made with the instantaneous spontaneity of instinct, rather than with the more deliberate consciousness of intelligence. Calculation is inadequate. An airplane must either keep moving or fall; there is no time to figure anything out. The sustained effort required to do so is outside the range of human mental power. It is therefore on the comparatively effortless processes of instinct that a pilot must depend.

That any other condition would destroy the effectiveness of flying will be apparent on a moment's reflection. If it were necessary for a pilot to direct his conscious attention to every movement of the controls he would have no time for anything else. Mere selection of a course or avoidance of obstacles would be difficult. Any useful mission would be impossible. The only solution, therefore, is to allow the subconscious mental processes to direct the actual manipulation of the controls, while the conscious mind is devoted to the purposes of the flight. An experienced pilot retains control in a flipper turn with no apparent effort while absorbed in examination of a field below him. It is the attainment of this degree of proficiency which requires the considerable amount of time and practice involved in the flight school course.

But if flying is an art, naval flying is a precise art. And it is here that the intelligence comes into full play. Mere instinctive ability to handle a plane is useless unless the pilot knows what to do with it. Every naval flight is made for some definite purpose. It is the responsibility of the pilot to accomplish that purpose in the most effective way. There are scores of rules, regulations and precautions, which experience has demonstrated necessary for security in flight. These must be understood and intelligently applied. An emergency arises, and some course of action must be immediately selected. The safety of plane and personnel depends on the pilot's judgment. In all these things it is the student's intelligence, rather than his instinct, on which he must depend.

And though flying is an art, the vagaries of temperament commonly associated with the latter word have no place in naval flying. Brilliancy of performance is appreciated, but not at the expense of dependability. Flight regulations and instructions come first. The budding ace who undertakes to make his own course rules, finds no difficulty in attracting the chief instruc-

tor's attention, as more than one young officer has discovered. Flying at Pensacola is carried on for purposes of training, not of exhibition.

Factors in Selection of Students. To complete satisfactorily the flight school course the student must possess certain qualifications. The determination of the relative ability of each student in these respects is the object of the checking system. On the results of the checks is based the selection of students, which operates by gradual elimination.

The first, and the one fundamental quality, for which a check instructor looks, is flying instinct. If a man's work indicates lack of the "feel of the air," it is useless for him to attempt to go on. It is undoubtedly a keen disappointment to many students to learn that this has no relation to intelligence or interest in aviation. If it is born in a man, he has it. If it is not, he cannot acquire it.

It must not be assumed, however, that a student is required to demonstrate a high degree of aptitude before he can solo. He must merely demonstrate its presence. It may be uncertain and only partially developed. But if it is sufficient to enable him to solo safely, he will be given the opportunity to develop it. On what he does with this opportunity depends his progress.

Once given this irreducible minimum of instinctive aptitude, the student's other qualities immediately assume equal importance. Mere possession of a high degree of instinctive ability by no means assures development into an unusually good naval aviator. Too often such ability is conducive to overconfidence and carelessness. The student of moderate instinctive ability who is painstaking and thorough in his work, is quite likely to develop into the better pilot. Consequently check instructors, particularly during later checks, lay as much emphasis on other qualities as they do on demonstration of the feel of the air.

Carefulness is one of the most necessary qualifications of a pilot. The student who, after starting his engine on the gravity tank, takes gaily off without turning on the main tank, is not going to get very far. Yet in every class two or three students have to make forced landings before this fact eventually impresses itself on them. Taxying in to the beach after a landing is also a simple operation if certain explicit rules laid down in the manual are followed. Yet every week or so someone is in too much of a hurry to bother with them. A "beach crash" results, and one or two planes go out of commission with gashes in their wings. One instance of negligence may be overlooked, but repeated instances must raise a reasonable doubt as to the student's aptitude for aviation.

Alertness in the air is at least of equal importance. LOOK AROUND is written in the manual in capital letters. There are any number of things which it may be vital to observe—approaching planes, shifts of wind, changes of course, anything that may affect safety. The student who goes charging around the bay with his eyes glued on the nose of his own plane is a potential crash. Some day he may meet a friend who is doing the same thing. Frequent exercise of the muscles of the neck is one of the surest guarantees of a ripe old age.

Obedience to orders is expected here, as everywhere in the Navy. Possibly some of the restrictions imposed may appear irksome or unnecessary. But they have been laid down by pilots of far greater experience than the student, for the purpose of insuring his safety. Strict adherence to all regulations is required at all times.

Accuracy in detail of performance is given considerable weight in grading a student. For instance, landings made five or ten degrees off wind instead of directly into it are considered sloppy flying. No damage to the plane is occasioned, nor is that alone sufficient to make a check unsatisfactory. But the instructor gets a poor impression. If the student can land at all, he can just as well land directly into the wind. No greater skill is required; merely a little extra attention. Reasonable accuracy in all such details as this is therefore expected.

The value which the student derives from an hour in the air depends largely on himself. Without some preparatory effort, an instruction flight will be merely a chaotic blur. He must know what he is trying to do and the theoretically correct way of doing it before he can make any intelligent practical effort. While on the beach, either before or after flight, he has the opportunity to go over maneuvers in his mind. It frequently occurs that discovery, during discussion with his instructor, of some important misunderstanding that has handi-

capped him, will enable him to show marked improvement in his work. But he must do his own thinking. His instructor can and will explain, demonstrate, answer questions. But he cannot do all the thinking too. On the mental effort which the student applies to analysis of his own mistakes depends very largely the value which he derives from each one of his limited number of hours in the air. And this mental effort serves as a reliable gauge of the interest which he takes in flying.

Self-confidence is vital to the student. Unless he has confidence in his ability to handle a plane safely he lacks one of the most essential qualifications of a naval aviator. It may perhaps be somewhat slow in developing, but twenty or twenty-five hours solo should bring it out. It must, however, be an intelligently controlled confidence. Mere cocksure assurance that ignores the limitations imposed by inexperience, is dangerous. The proper self-confidence is intelligently sure within its own limits, but knows that those limits can be expanded only a little at a time.

The acid test of the student's ability is an emergency. His manner in emergency is not only the summation of all his other qualifications, but the indication of that innate intangible quality which keeps a man's head clear and his hand steady when things are happening fast. Unless he can come through in a tight place, a student has no business in aviation. For if he flies long enough, sooner or later he is going to meet a real emergency. When that happens there is no second check. It has to be right the first shot. Therefore, as the student gets time in the air, check instructors put more and more stress on manner in emergency.

In every emergency created artificially on a check, there is some course of action which will easily insure personal safety. It is the student's business to be ready at all times for an emergency, to know what he is going to do and, when the proper time comes, to do it promptly and effectively without jeopardizing control of the plane. The average student will solve at least four out of five emergencies satisfactorily after twenty-five hours solo.

A good record is an invaluable asset to the student. His relative standing in the class, published after completion of work in each type of plane, is determined by the average of all reports of his checks and of any special reports of crashes, beach crashes, or of any other inferior work. A high standing is naturally desirable. But of even greater importance is the value of a good record in case for any reason he ever goes up before a flight board. It is the best, and almost always the conclusive, argument for another chance. The extra effort involved in developing carefulness, alertness, accuracy and habitual obedience to orders, may some day be the decisive factor enabling him to stay in aviation.

Causes of Discontinuation of Training. A fairly large percentage of each class fails to complete the course. Of this percentage approximately half are unable to qualify for solo. After completion of solo checks there is a gradual but steady attrition which accounts for the remainder. The question can now be considered as to the causes of these failures. What factors determine the check instructor's decision to report a student unsatisfactory? Is it merely luck that one student passes while another fails, or is there some definite method of measuring a student's ability?

In the first place, there is no mathematical method of calculating exactly aptitude for aviation. The elements which constitute it cannot be graded with the precision of an examination paper. They are too intangible. The report of the check must therefore depend on the instructor's individual judgment. The possibility of error must consequently be admitted. Instructors, being human, are not infallible. It is for this reason that two unsatisfactory checks are required to bring a man before a flight board. But an experienced instructor develops a high degree of accuracy in estimating the ability of students. And when two check instructors agree that a man's work is not satisfactory, the chance that they are both wrong is negligible.

Of the students who, though passed on indubitable evidences of instinctive aptitude, nevertheless exhibit uncertainty in their actual work, some inevitably fail to develop that aptitude sufficiently to keep up with the rising standards required on checks. Erratic landings, unrecognized slips and skids, jerky and uncertain movements of the controls indicate a lack of real mastery of the plane. Though control may not actually be lost, there is no assurance that it would not be lost at some future time.

Consequently a recommendation to drop is necessary.

Another group of students have fair aptitude but fail on account of a lack of consistency. Check pilots know them as "in-and-outers." One day they fly smoothly and pass a good check. The next their work is ragged and sloppy. The reasons for this are probably as various as the individuals, but whatever they are, they disqualify a man for duty where he must be ready to fly whenever ordered into the air.

An occasional student who has little instinctive feel of the air, manages to pass a solo check by learning the proper movements of the controls sufficiently to perform them in a mechanical fashion. He has, however, no real basis on which to progress. His brain must function at top speed, merely to retain control, and he cannot increase that speed. Such students quickly drop out as the required standards of performance rise.

A certain number of students who have satisfactory aptitude undoubtedly fail merely on account of lack of application. While it is frequently difficult to prove this cause definitely, there is good reason for assigning it in some cases. Normal progress cannot be made by the student who fails to take time on the beach to analyze his mistakes. Nor does the passing of one good check warrant the devotion of the next hour or so to an aërial joy-ride around the bay. Full value from each hour can be secured only by constant practice of maneuvers and persistent application to the business of analyzing mistakes. The required standards can be satisfactorily met only when all time in the air is effectively utilized.

In every class are found a few students whose only lack is in their manner of handling an emergency. Out in the middle of the bay, free from distractions, they give every evidence of satisfactory aptitude. But in close quarters where clear thinking and quick action are imperative, they go to pieces. Some turn the wrong way. Some hesitate until it is too late, or else do nothing at all. A few attempt the impossible, and more than one check pilot has held his breath as he shoved the yoke forward, jammed on the rudder and felt the ship stagger clear of an imminent spin fifty feet off the beach. But whatever happens there can be only one verdict.

Finally, there is "check shyness" as a cause of unsatisfactory checks. A student gives, when flying with his instructor, adequate evidence of satisfactory ability, and then loses his effectiveness on a check. There is a wide-spread belief among students that a good many checks go wrong on this account, and that thereby much promising material is lost to aviation. So far as the first part of this belief is concerned, there is undoubtedly some foundation for it. But the second part, though at first glance it may appear logical, does not follow. A large and ominous clump of pine trees seen over a dead motor is at least as disquieting a sight as the back of a check instructor's head. What assurance is there that the effect would not be the same? Nervousness is merely a fundamental lack of manner in emergency.

There exists to some extent among students an unfortunate, and yet after all a natural and understandable, impression that the principal object of check instructors is to "bust" as many students as possible. Too many of them regard checks as contests between hostile forces. This impression is doubtless nourished by the fact that check instructors are much more chary of praise than of criticism. Naturally there is seldom any lack of ground for the latter, and as it is the object of the check, it must be made. Instructors would gladly add any praise deserved, but experience has taught them that this is not wise. The student gets enough encouragement from his own instructor, and any approval, beyond the statement that his progress is satisfactory, would too frequently obliterate the effect of the criticism. Consequently an unthinking student may gain the impression that a check instructor is a carping critic whose only regret is the reluctantly admitted necessity of passing him.

As a matter of fact nothing is farther from the truth. The object of checks is to improve as much as to eliminate. Any check pilot will gladly spend half an hour explaining a student's mistakes to him, if he believes that such explanation will be of any assistance in meeting the requirements of the flight school. The function of the station is to produce naval aviators, and it would be a failure in a most important duty, if the check instructor neglected any opportunity to improve a student's work. But on the other hand, he is charged with the responsibility of maintaining the

standards of the flight school. It would be equal dereliction of duty to recommend retain, when better judgment says drop.

And, though probably no student ever sees it that way, the recommendation to drop is in reality a favor to him. There have been times in the past when, with less experience on which to rely, the standards of Pensacola were not as high as they are now. And there are in the records of aviation, reports of not a few serious, sometimes fatal, crashes of planes piloted by men who, under the present standards, would never have worn wings. It was no favor to those men to pass them. It would be no favor now to pass the man whom two experienced check instructors say is not quite good enough. But disappointment is only human, and usually it is hard to see it that way.

The Finished Product. The preceding pages may have seemed to emphasize the difficulties confronting the student in the flight school, and may have suggested that exceptional ability is required. As a matter of fact the majority of students complete the course. A high degree of natural aptitude is of less importance than common sense and a capacity for hard work. Given a fair amount of instinctive ability and a reasonably cool head, the student who applies himself intelligently and conscientiously to the business of learning to fly, has every prospect of receiving a designation as a naval aviator.

The fact that the standards of the flight school are high, is the best guarantee of the student's safety. He must make himself a competent pilot in order to meet its requirements. His feel of the air is developed by constant practice and criticism. He cannot lapse into careless or lax habits if he is going to stay in the class. He is forced to develop constant alertness to meet the emergencies which he is given on checks. His experience includes every phase of elementary flying which he may need to know. When therefore he successfully completes the flight school course, he is assured of the fact that he can fly at least reasonably well.

That is the object of the checking system—to eliminate all students who lack any qualifications necessary to become competent pilots. Because of it the graduate of the Naval Air Station is able to take his place in any operating squadron of the fleet with only brief instruction in the routine of that particular organization. Once he has passed the required number of checks the flight school is willing to vouch for his ability. He cannot be called an experienced pilot until he has had several years of fleet flying. But he is ready to begin that experience.

The average student has hours now and then when a pair of wings seems a very distant possibility. The apparently effortless ease and accuracy with which his instructor handles the plane appears an unattainable goal. A check gone wrong, or barely passed with a warning, looms as an ominous forecast of an abruptly ended aviation career. The perversity with which a plane persists in spinning out of all his attempts at a falling leaf is prolifically productive of discouragement.

But his checks improve little by little. He manages to drag four falls of a falling leaf out of a reluctant stunt ship. He surprises himself by making a good shot at the boat on his first attempt. And then one day he starts off to Corry Field to fly landplanes. Time passes quickly there, and before long his name is chalked up on the board for a Pascagoula—Mobile hop. Two or three days later he finishes landplanes, and goes back to the station to fly *CS's.* With good weather three weeks will be sufficient for this. And so one day he comes down from a final check that has seemed remarkably simple and hears the brief comment, "a pretty good ride." His last check is behind him.

Presently there appears from official channels a communication that he has more than once despaired of seeing. It bears his name and on it he reads the words, "Pursuant to qualification before an examining board, ... I have this day appointed the above named officer a naval aviator and detailed him to duty involving flying in aircraft." He has earned his wings.

After Jutland

By R. H. Gibson

THE German fleet fled back to harbor and never again left the fortified bases to try conclusions with the Grand Fleet. So does the press and public pronounce judgment on that historic conflict. Is it true? If ever proverb about half-truths has any meaning, it is surely so in this instance. The High Sea Fleet *did* flee, but it came out again many times afterwards, as it had done before the combat off the Danish coast. When British feelings were too tender to bear the unpalatable truth, Captain Persius administered a sop by saying that "after June 1 it was clear to every thinking man that the battle must be the last," and so the legend grew. Only lately has the public a vague idea that its preconceptions about the battle may possibly be unsound.

Let us glance at the score of excursions which the German fleet made both before and after Jutland. The High Sea Fleet was under the command of von Ingenohl for the first six months, but his hands were so tied by the military party that he was not allowed to take the slightest risk. Nevertheless, during this time, there was the abortive mining raid of the *Königin Luise* on August 5, the extended cruiser and destroyer reconnaissances of August 12, 18, and 21, followed up by the *Nautilus* and *Albatross* mine-laying expeditions off the Humber and Tyne on the night of August 25. Lastly, on October 17, a torpedo boat division on its way to mine the Thames estuary was intercepted and destroyed by the Harwich forces.

The first of the long series of coastal raids was made on November 3. The same plan was adhered to throughout the war, with modifications. The Germans hoped, by coastal bombardment, to draw down south the Grand Fleet, having previously prepared either submarine or mine traps along the expected route south, and to force an action before the various parts had united. Generally speaking, the raids seem to have been more distastrous to the Germans, although the High Sea Fleet came out in support of the cruisers. In this first raid on Yarmouth, Hipper lost the *Yorck* on his return to Jade Bay; he had dropped mines in his wake when he was falling back on the battle fleet to the north of Terschelling.

In the second attack, on December 16, when Hipper appeared off Hartlepool and Scarborough, the High Sea Fleet came out to support the retiring battle cruisers; mines were again dropped overboard, and the raiders just escaped the British Second Battle Squadron as they steamed east through the gap in the east coast mine-field. When Hipper came out for the third time on January 24, to reconnoiter off the Dogger Bank, he ran across Beatty's battle-cruisers; the *Blücher* was sunk and the *Seydlitz* was very badly damaged, but Hipper regained the protection of the supporting battle fleet.

Von Ingenohl was retired soon after this, but under von Pohl the Germans were hardly more successful. There were six cruises to the northwest of Heligoland during the spring, in the last of which, on May 30, 1915, the small cruiser *Danzig* was damaged by mine. In September, a run into the Hoofden (the waters between Norfolk and Holland) and another in October, towards Horns Reef, were also barren of result.

Von Pohl died in February, 1916. He had been succeeded on January 18 by Scheer, who started an energetic campaign right away. Opening with a destroyer reconnaissance of the Dogger Bank on February 10, when the Fifteenth Mine-sweeping Flotilla was attacked and the *Arabis* sunk, Scheer had the battle cruisers lying in Schilling Roads and the light cruisers off Emden ready for any emergency. Next, on March 10, the High Sea Fleet, in conjunction with a Zeppelin raid on Hull, cruised into the Hoofden but did not sight the British squadrons. Followed the Easter

bombardment of Lowestoft and Yarmouth on April 24 by Hipper, with the battle fleet in support well out of the Bight. On the way across, the *Seydlitz* bumped into a mine and was sent back under escort. The Harwich Force got knocked about by the battle cruisers.

Scheer planned to bombard Sunderland in May, as he was convinced that the attacks on Lowestoft were too far south to ensure any real chance of cutting off a part of the Grand Fleet, particularly the Battle Cruiser Fleet. Sixteen submarines were sent out to lie off the eastern bases so that they could attack the Grand Fleet as it hurried south to intercept Hipper's battle cruisers. He intended to have the High Sea Fleet well out in support, and he relied on aërial reconnaissance to insure that a superior British force could not cut off the retreat. Bad weather set in and, when the limit of the submarines' endurance had been reached, Scheer decided to substitute for his plan a swift raid on the Scandinavian traffic to these islands. The Battle of Jutland on May 31 was the result, because Scheer did not know that the Grand Fleet had been informed that the German battle cruisers, if not the battle fleet, were putting to sea. In the general engagement which followed, by skilful tactics, Scheer extricated his fleet from perilous positions and by desperate expedients eventually succeeded in breaking through to the east and safety during the hours of darkness.

Now, according to the generally accepted opinion, the career of the High Sea Fleet ended there and then. Not a bit of it! As soon as a raiding squadron of sorts could be raked together, Scheer determined to carry out his Sunderland scheme: as the *Derfflinger* and *Seydlitz* were still under repair, Hipper set off with the two remaining battle cruisers and the new *Bayern*, *Markgraf* and *Grosser Kurfurst*, followed some twenty miles behind by the two repaired squadrons of battleships. A number of submarines were posted off the Forth, off the Humber, and off Terschelling, and eight Zeppelins reconnoitered for the fleet. Early on August 19, the British submarine *E-23* sighted the battle fleet half way across and slipped a torpedo into the *Westfalen*, which had to be sent back. The element of surprise had now vanished, even if suspicions had not been aroused by the number of submarines and Zeppelins which were seen. When fifty miles short of the goal, Scheer turned back; warned by the Zeppelins that the Grand Fleet was rapidly converging on his course from the north, he just succeeded in escaping a more disastrous Jutland. During the ensuing search for the enemy, the light cruisers *Nottingham* and *Falmouth* fell victims to the submarines.

Bad weather prevented a similar operation next month, and the necessary submarines for such a plan were required in October for the new trade campaign. Scheer was compelled to substitute torpedo boats, and on October 19, with the battle fleet in support, they were sent out. Bad weather once again frustrated the cruise, but the Dover raid of October 26, when the *Flirt* was sunk, was an extension of the general scheme.

The remaining cruise of 1916 was quite incidental. On November 4, the submarine *U-20* stranded off Harboere, Jutland, and a squadron of battleships and battle cruisers was sent to cover the attempt to refloat her. This tempting target was too good to be missed and Commander Laurence in *J-1* torpedoed both the *Markgraf* and *Kronprinz*, though not fatally.

The Kaiser stopped an expedition into the Hoofden in March, 1917, on the grounds that aërial reconnaissance, which was impossible in the prevailing weather, was indispensable, and on March 5, the *Grosser Kurfurst* and *Kronprinz* were in collision during squadron practice in the Bight. The serious mutiny of 1917 crippled any activity of the fleet in the summer, but a tonic was administered by employing the fleet in the capture of the Baltic Islands during October. While the main fleet was thus occupied, a swift raid on the Lerwick-Bergen convoys was made by the fast cruisers *Bremse* and *Brummer*. At dawn on October 17, a convoy of ten steamers, escorted by the destroyers *Mary Rose* and *Strongbow*, was encountered and quickly sent to the bottom.

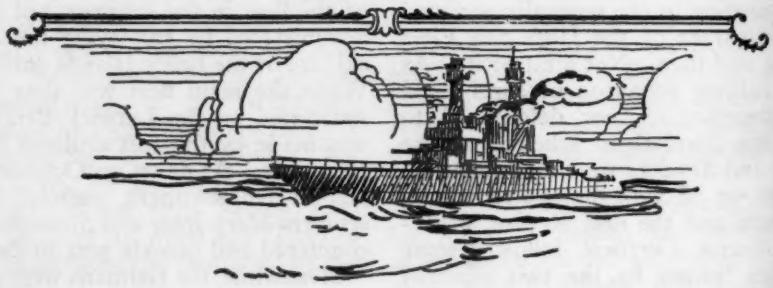
Meanwhile, the Germans were sorely hampered with enemy mining of the Bight, and when they were reconnoitering the fields on November 17, they came upon a squadron of British light forces and fell behind the mine-fields on the support of the battleships *Kaiser* and *Kaiserin*. Both sides received several hits.

The second convoy attack, made by two destroyer divisions simultaneously in two different places, was hardly more successful. One division destroyed two steamers and a

trawler off the east coast and retired. The other, making northwards, encountered bad weather and was returning when, to the south, the convoy turned up, escorted by the destroyers *Partridge* and *Pellew* and five armed trawlers. Despite the gallant defense which the escort put up, only the *Pellew* escaped, together with one trawler and one steamer. As a result of the second attack, the whole convoy organization was recast and, except by sending out heavier raiding forces, a repetition was impossible.

As a matter of fact, the Germans did develop the convoy attack and it very nearly brought about a second Jutland battle. On April 24, 1918, Hipper was sent north to intercept a convoy, and Scheer followed on behind. The reason for the employment of such large forces was that the convoys were now covered by squadrons of the Grand Fleet which frequently made sweeps across the Norwegian coast. When off Stavanger the blades of one of the *Moltke's* propellers dropped off, the engines began to race, and within a few minutes enormous damage was caused to her machinery. Hipper detached her to await the arrival of Scheer, when the project was given up. When off Lyst, the British submarine *E-42* got a torpedo into the crippled battle cruiser, which, nevertheless, regained port. Some weeks later, Scheer was promoted to chief of the Admiralty Staff, and was succeeded by Hipper. This was the last cruise of the German fleet for the revolt broke out afresh in October, when the High Sea Fleet was about to sail on the last desperate sally.

Here, then, is a complete refutation that the German fleet crawled into port on June 1, 1916, and only emerged to surrender ignominiously in the Firth of Forth over two years later. Annihilation, not heroics, is war, and unless Scheer could cut off a part of the Grand Fleet and crush it, he would have been guilty of criminal folly in rushing on the guns of his superior antagonist. Jutland was a nasty shock for the Germans, but they recovered from it remarkably soon, and resumed their strategy almost uninterruptedly.



Courtesy of Loening Aero Engineering Corporation

UNITED STATES NAVY LOENING AMPHIBIAN PLANES USED IN THE SURVEY OF ALASKA IN THE SUMMER OF 1926
The power plant is a Packard 1500 Inverted Engine. This plane can land on either land or water.

Courtesy of Bureau of Aeronautics, Navy Department, Washington

BAIRD GLACIER AND DEVIL'S THUMB, ALASKA

Along International Boundary line; mountain peaks in distance are over 11,000 feet. Photo taken by Navy Alaskan Aërial Survey Expedition 20 miles inland from Le Coute Bay.

BAIRD GLACIER AND DEVIL'S THUMB, ALASKA

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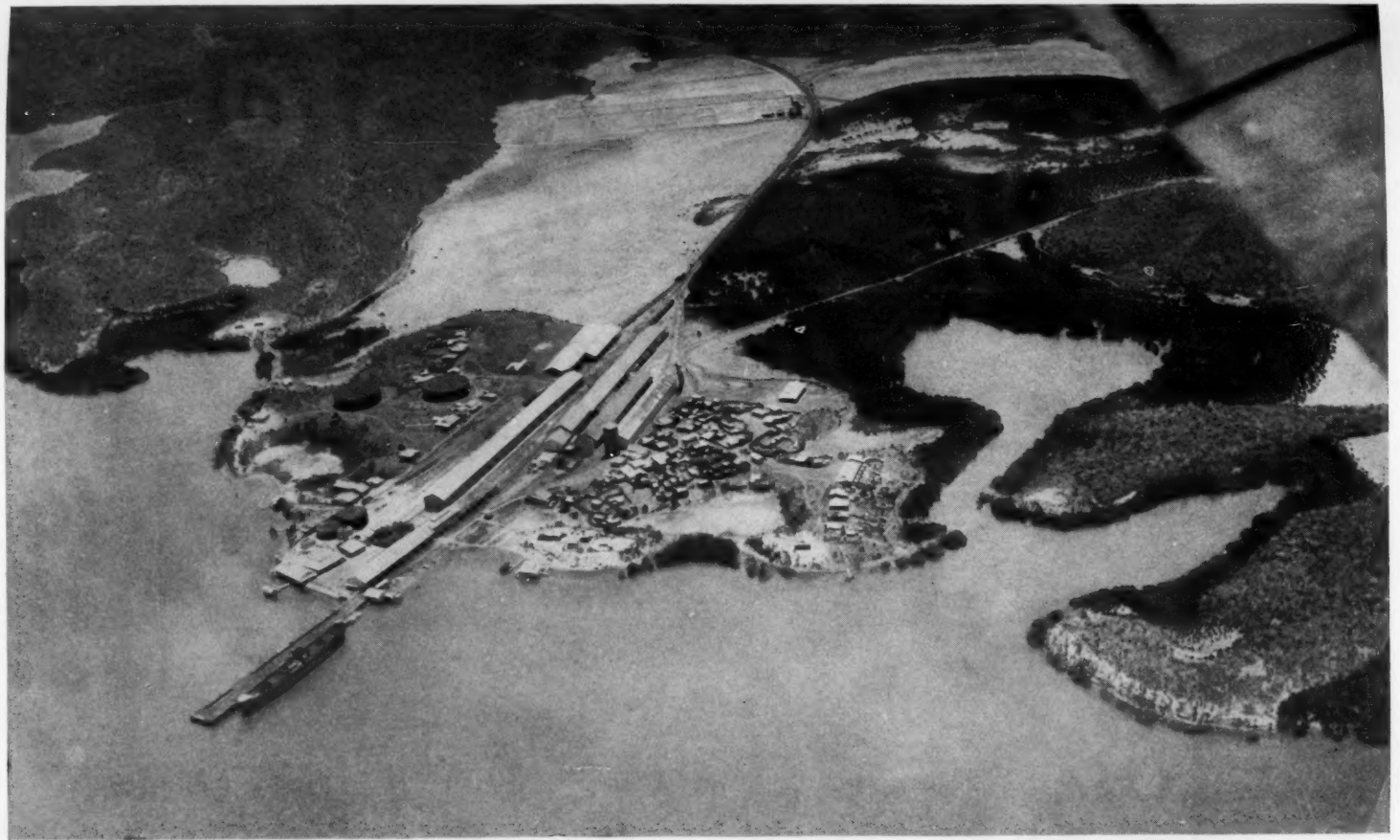
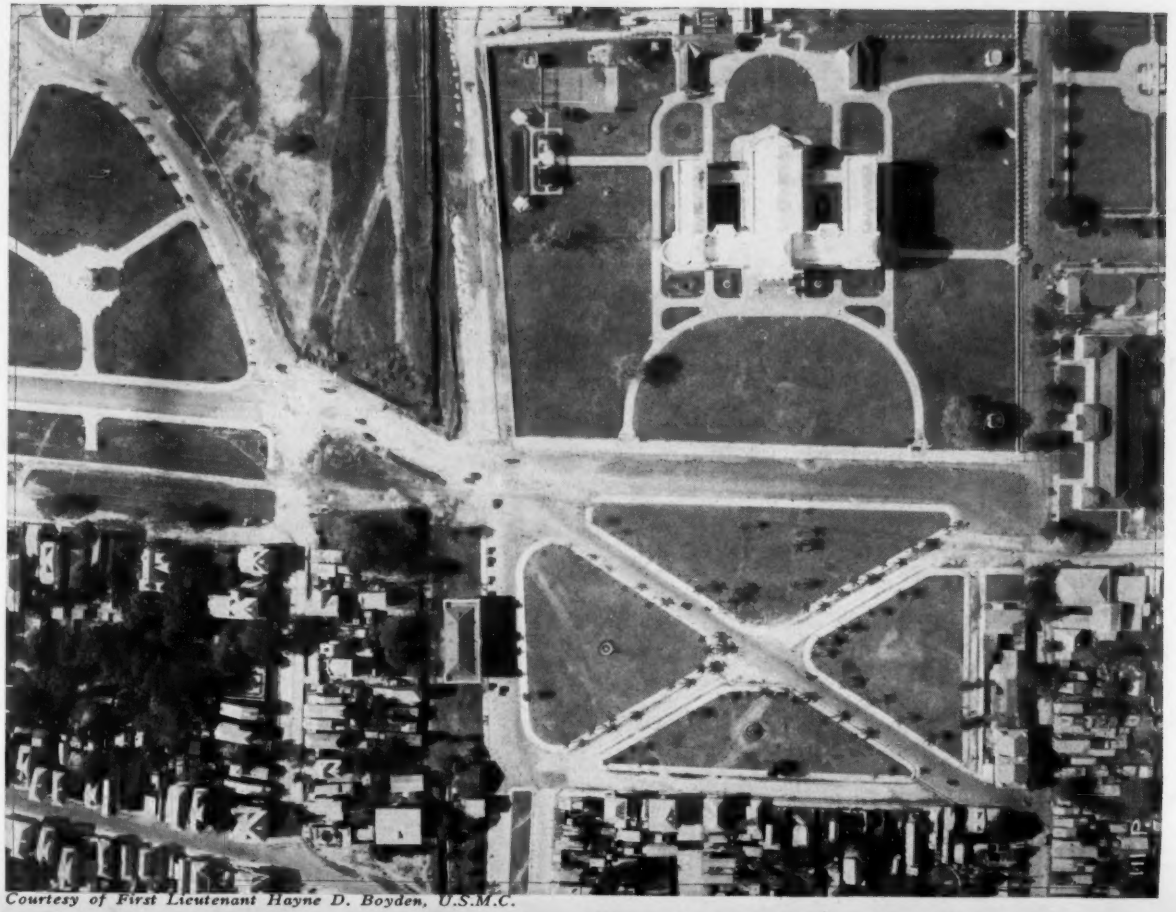


Courtesy of The Bureau of Aeronautics, Navy Department, Washington.

AIRPLANE MAPPING—VIEW OF BOQUERÒN, GUANTANAMO BAY, CUBA, FROM AN AIRPLANE



Courtesy of First Lieutenant Hayne D. Boyden, U.S.M.C.

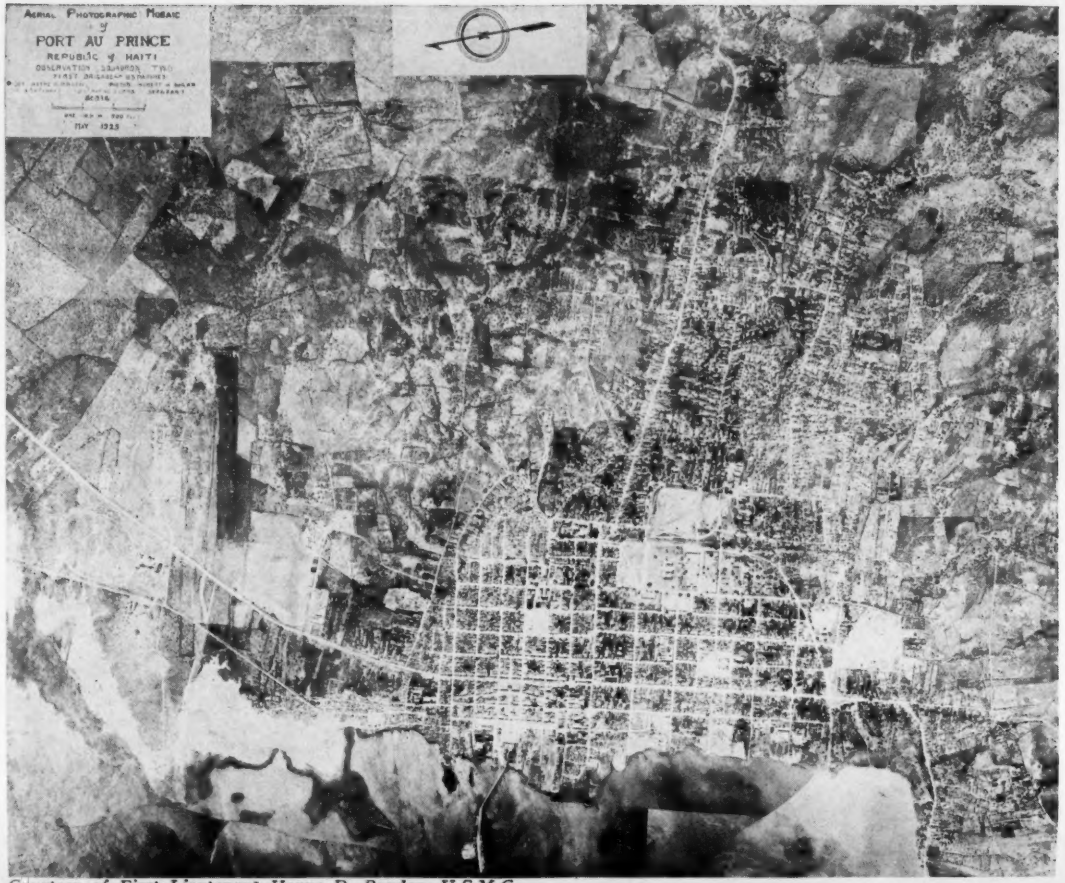
PALACE AND PARK IN PORT AU PRINCE, HAITI
Taken at an altitude of 2,000 feet. Scale 1—2,000 (See page 793)

Courtesy of First Lieutenant Hayne D. Boyden, U.S.M.C.

PALACE AND PARK IN PORT AU PRINCE, HAITI
Taken at an altitude of 2,000 feet. Scale 1—2,000 (See page 793)

Courtesy of First Lieutenant Hayne D. Boyden, U.S.M.C.

CUL DE SAC—TAKEN AT A HEIGHT OF 10,000 FEET (See page 793)



Courtesy of First Lieutenant Hayne D. Boyden, U.S.M.C.

PORT AU PRINCE, HAITI, FROM A HEIGHT OF 6,000 FEET (See page 793)

Courtesy of First Lieutenant Hayne D. Boyden, U.S.M.C.

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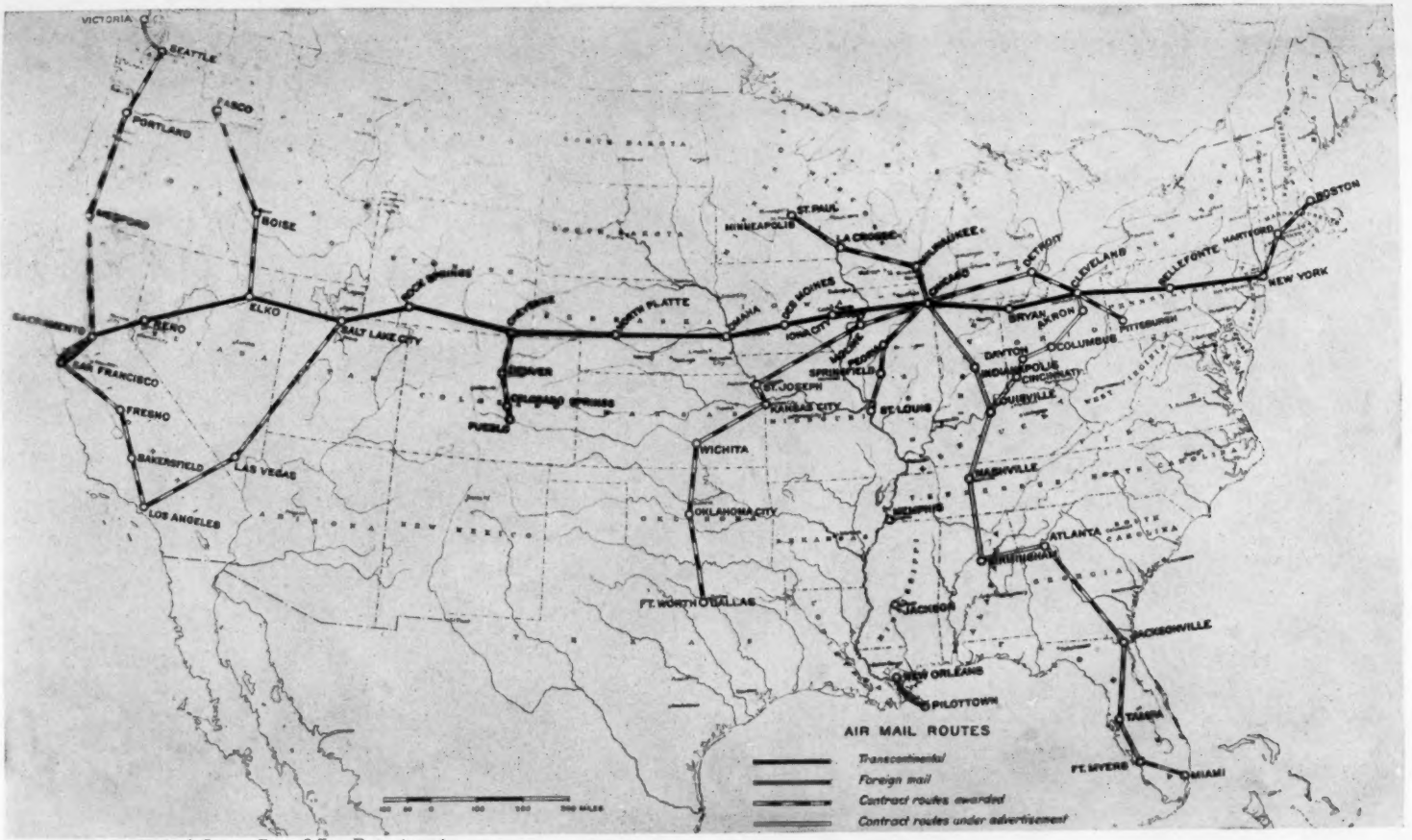


Courtesy of the United States Post Office Department

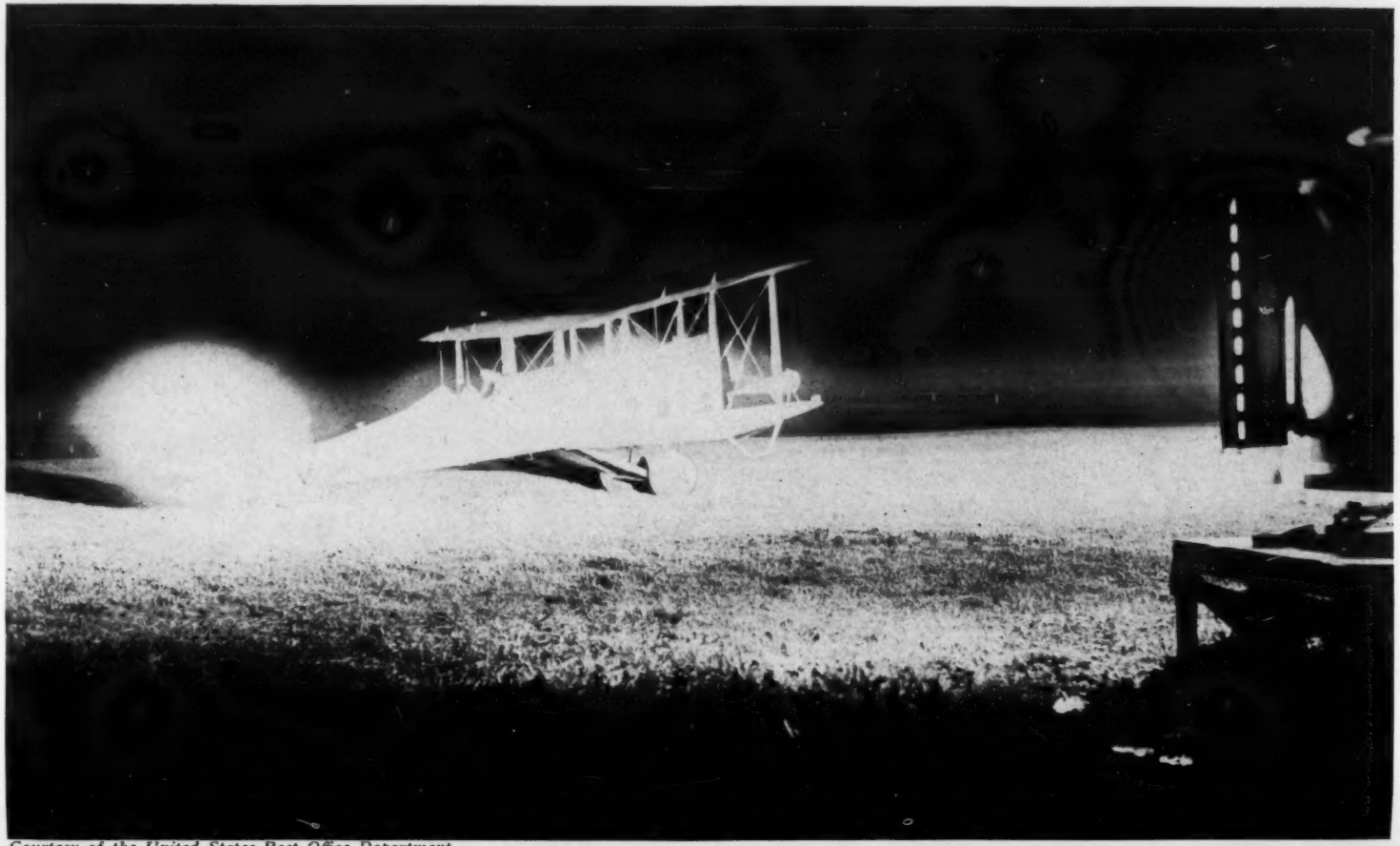
UNITED STATES AIR MAIL ROUTES

Courtesy of the United States Post Office Department

On the Overland Air Mail Route

Courtesy of the United States Post Office Department

A Plane of the Air Mail Service. Typical of the Ones Flown by Lindbergh in this Service. He was Equally at Home in the Air in French and British Military Planes



Courtesy of the United States Post Office Department

THE LANDING FIELD AT NIGHT ILLUMINATED BY FLOOD LIGHTS. THE FRENCH LANDING FIELD AT LE BOURGET WAS EQUALLY WELL LIGHTED WHEN LINDBERGH LANDED IN PARIS BUT THE HAZARDS WERE MUCH GREATER DUE TO THE CROWDS EAGER TO WELCOME HIM

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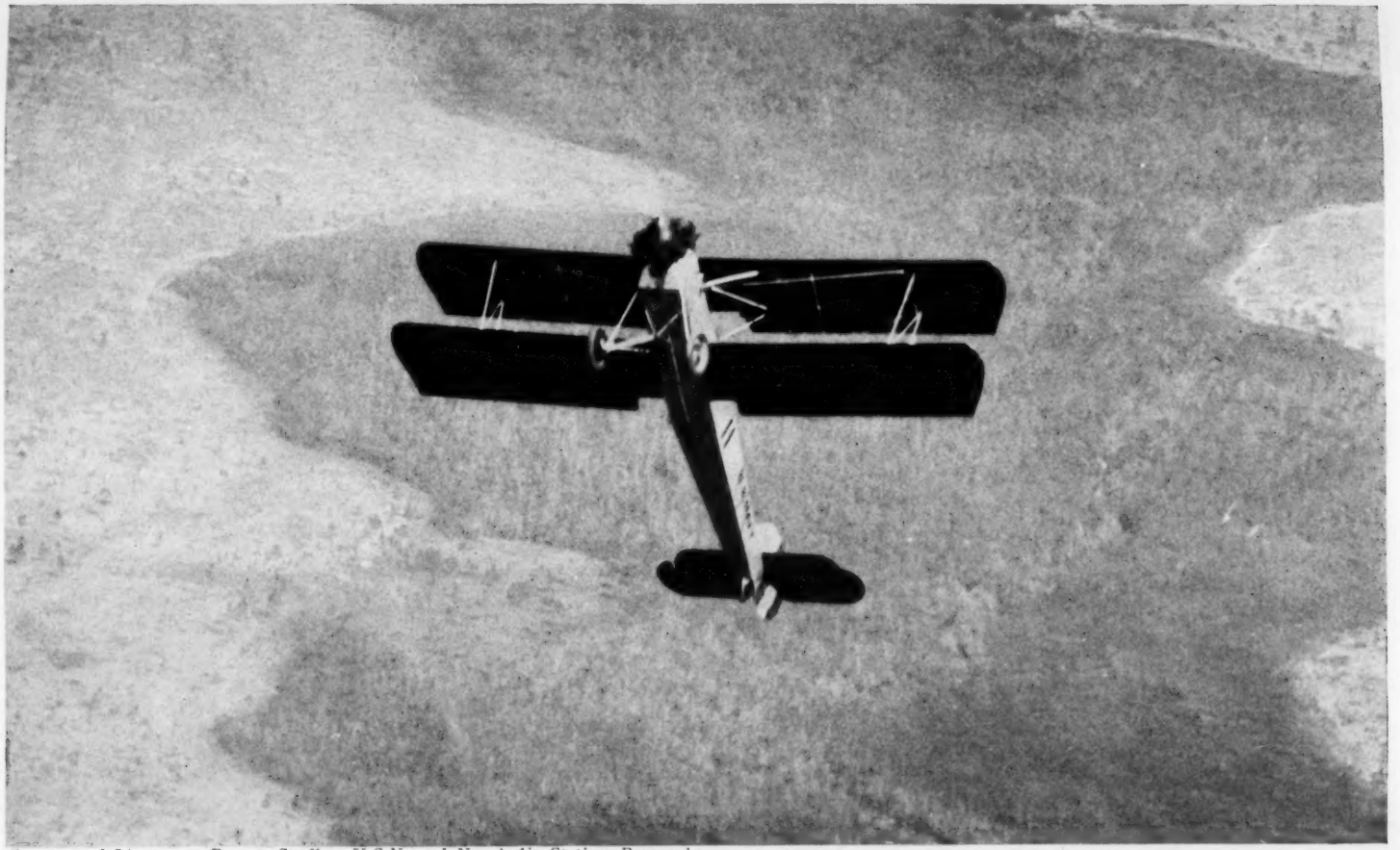


Courtesy of Lieutenant Barrett Studley, U.S.N. and Naval Air Station, Pensacola

WHERE THE NAVY LEARNS TO FLY—ENTERING A LOOP

(See article, page 764, by Lieutenant Studley)

Courtesy of Lieutenant Barrett Studley, U.S.N. and Naval Air Station, Pensacola

INSTRUCTION IN LOOPING AT FLYING SCHOOL, PENSACOLA
(See article, page 764, by Lieutenant Studley)

INSTRUCTION IN LOOPING AT FLYING SCHOOL, PENSACOLA
(See article, page 764, by Lieutenant Studley)

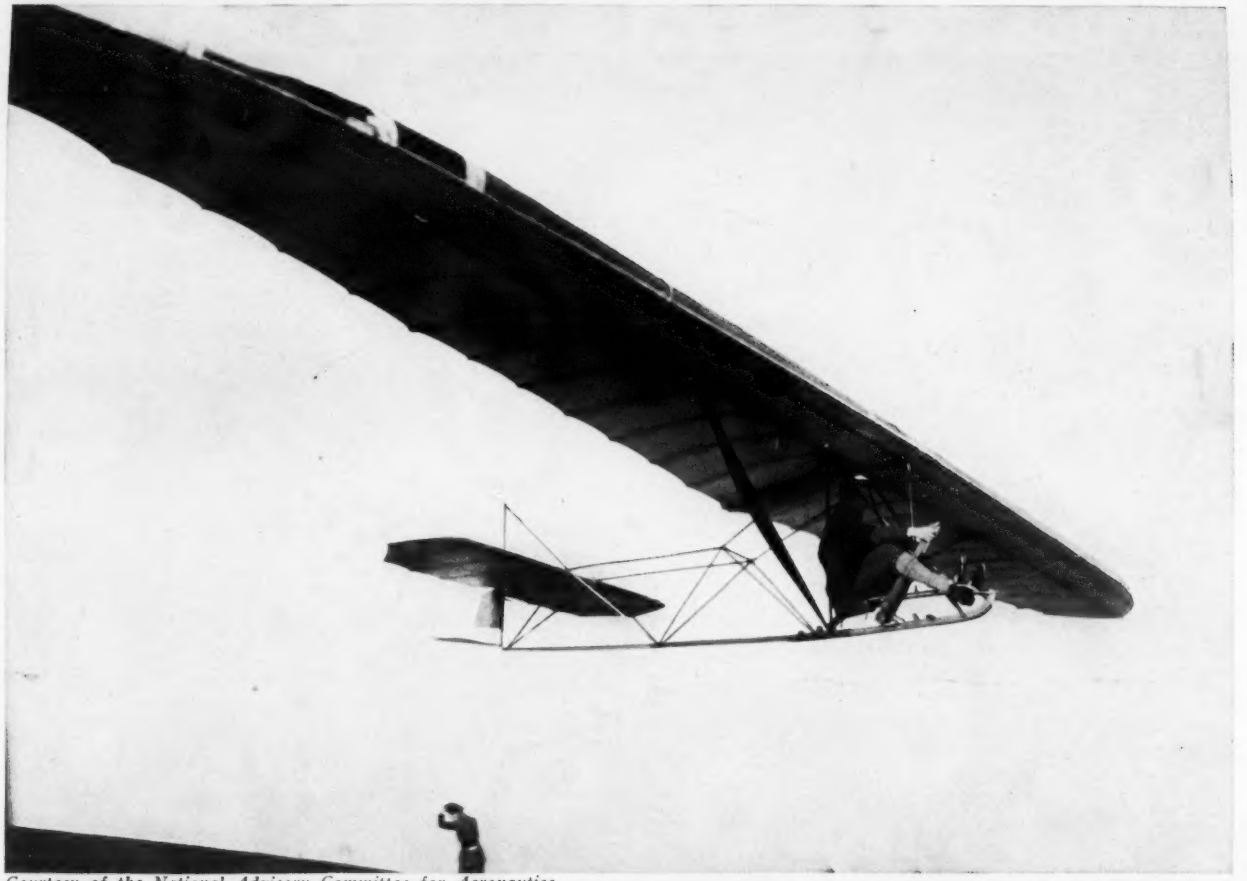
Courtesy of Lieutenant Barrett Studley, U.S.N. and Naval Air Station, Pensacola

A SPLIT-S TURN, INSTRUCTION AT FLYING SCHOOL, PENSACOLA
(See article, page 764, by Lieutenant Studley)

Courtesy of the National Advisory Committee for Aeronautics

TAKING OFF—THE BERLIN GLIDER. IT GETS ITS "TAKE OFF," OR IS LAUNCHED BY MEN, ONE AT EACH END, PULLING ON THE LAUNCHING LINES, THE GLIDER BEING HEADED INTO THE WIND

TAKING OFF—THE BERLIN GLIDER. IT GETS ITS "TAKE OFF," OR IS LAUNCHED BY MEN, ONE AT EACH END, PULLING ON THE LAUNCHING LINES, THE GLIDER BEING HEADED INTO THE WIND



Courtesy of the National Advisory Committee for Aeronautics

RISING—THE HARTH-MESSERSCHMITT GLIDER—SPAN 46 FEET. GERMANY HAVING BEEN FORBIDDEN BY THE "TREATY OF VERSAILLES" TO HAVE MILITARY OR NAVAL PLANES, HAS TURNED HER ATTENTION TO THIS FORM OF AVIATION AND CIVIL AVIATION

Courtesy of the National Advisory Committee for Aeronautics

IN FULL FLIGHT—THE HANNOVER "GREIF" GLIDER. SO SKILLFUL HAVE THE GERMANS BECOME THAT ONE FERDINAND SCHULZ RECENTLY REMAINED IN THE AIR FOR 14 HOURS AND 7 MINUTES, A NEW WORLD'S RECORD FOR A PLANE WITHOUT AN ENGINE

Courtesy of the National Advisory Committee for Aeronautics

In Full Flight—The Hannover "Greif" Glider. So Skillful Have the Germans Become That One Ferdinand Schulz Recently Remained in the Air for 14 Hours and 7 Minutes, a New World's Record for a Plane Without an Engine

Use *of* Aircraft *for* Hydrographic Surveying

By Lieutenant Logan C. Ramsey, *U. S. Navy*

(See pages xxxiii, xxxiv, xxxv)

FROM a very unpretentious beginning, the utilization of aircraft in hydrographic surveying has developed until it is the policy of the Hydrographic Office of the United States Navy to profit by all of its possible applications. By thus using aircraft and aërial photographs to the fullest extent the cost of a survey, in both time and money, is considerably reduced, and, in addition, a superior product is obtained.

For a number of years the value of aërial photographs for the purpose of hydrographic surveying was questioned. About 1916, the value of such photographs was definitely established and an endeavor made to obtain some for experimental purposes. Unfortunately at this time the aëronautical organization of the Navy was extremely small and fully occupied with other and more essential military duties. For these reasons it was not until after the World War with its consequent expansion of the aviation activities of the United States Navy that planes or pilots became available.

In 1919 a small area of about fifty square miles covering Guantanamo Bay was photographed from the air. From that time the number of instances in which aircraft were used increased in geometrical ratio until for the past three years no survey undertaken by this office has been without the services of aircraft and aërial photographers.

In addition to work accomplished by naval aircraft for other governmental activities such as topographic surveys for the Interior Department, Department of Agriculture, etc., the following surveys have been and are being aided by aircraft: north coast of Cuba, south coast of Cuba, harbor of Mariel, Cuba, Pearl Harbor, T.H., and coast of Venezuela.

All projected surveys include the use of photographs taken from planes.

The reason for the adoption of the policy of utilization of aircraft in all Hydrographic Office surveys undertaken is the two-fold advantage that may be gained by this auxiliary. Not only do the planes and aërial photographs aid the production of the chart technically, but they are also of great value in expediting the logistical side of a survey expedition.

In expediting the logistical supply of a survey the work of the aircraft falls naturally into two headings: first, mechanical aid such as transportation of personnel and supplies to otherwise inaccessible spots or the saving of time that might result by such transfer by air; second, semi-technical services such as reconnaissance flights and the utilization of photographs taken in advance of the actual surveys by ground methods to aid in determining the location of stations, signals, etc.

In considering the first of these aids, the type of plane and its equipment must be considered. Generally speaking, hydrographic surveys undertaken by this office are conducted chiefly in areas previously unsurveyed or where the survey is of such early date as to give doubts as to its accuracy. In addition, these areas generally abound in more or less uninhabited and uncultivated areas. Thus, in addition to the fact that they are along the coast, the natural landing areas upon which an airplane is capable of landing are few and far between. The working base of the survey has in addition a ship, generally a converted yacht, of the U. S. Navy. Therefore, the utilization of a landplane is generally impracticable and the use of a seaplane more feasible. In most areas, due to the conformation of the coast, it occasionally becomes necessary for the planes to fly inland for considerable distance where in case of engine or other trouble the water could not be reached. For these and other minor reasons, the use of an

amphibian plane in a hydrographic survey is most desirable. The type of plane used up to the present time with the greatest success for such work has been the Loening amphibian plane modified for aërial photography. It is with this type of plane that practically all of the recent surveys undertaken by the Navy, both for the Hydrographic Office and for other governmental activities, have been conducted.

In the case of the Hydrographic Office survey of the Gulf of Venezuela, an occasion arose for the transfer of a shore party to a spot on the western side of a long narrow lagoon. Due to the presence of an unbroken reef about a mile off shore, it was impossible to transfer the men and their delicate instruments by means of a small boat. The plane, however, was able to embark the party and their equipment, take off from the water, and land the party inside the reef, at the desired point. Had not the plane been available for this service, a march of approximately forty-five miles around the shores of this inlet and through the most dense of tropical jungles would have been necessary. In this one small item a considerable saving of time, money and labor was made possible. In numerous other instances, the transfer of personnel by air has eliminated the necessity of moving the surveying vessel.

Frequently actual conditions existing on the survey area vary considerably from those on the old charts. Under such conditions and, of course, also when the area has been previously unsurveyed, a reconnaissance flight in which the hydrographic engineers are carried is of great value. Certain areas may be shown or may be discovered to be of little value and their intensive investigation unnecessary.

The other phase of logistical aid comes when aërial photographs are available in advance of the time for the ground work. Whenever the survey area is of such an extent that more than one season is required to complete the work, it is the standard policy of this office for aërial photographs of the area to be taken during the year previous to the survey by ground methods. By a study of these photographs the most favorable positions for triangulation stations, signals, etc., may be determined. Locations which from a study of existing information are apparently most desirable may, when the aërial photographs are studied, turn out to be inaccessible or otherwise undesirable. For instance, in the Gulf of Venezuela survey a certain location along the shore line had been tentatively chosen as the site of a hundred-foot tower. When the aërial photographs, both vertical and oblique, were studied it became apparent that some other position would have to be selected. The presence of a fairly high bluff with practically no beach extending along the coast line about one and one-half miles in each direction from the selected site precluded the landing of necessary material in the previously determined vicinity. By means of the information afforded by these photographs, a new site just as advantageously located and much more accessible was selected.

Another instance of this kind occurred along the North Coast of Cuba. A certain small island from a study of a chart based on a survey made some fifty years ago appeared to be a logical location for a triangulation station. The aërial photographs, however, indicated that the true position of this island varied considerably from the supposed position and it was therefore unsuitable for a station of this description. A second site more advantageously located was selected and a close inspection of aërial photographs showed that the erection of a tower would be extremely difficult due to the marshy characteristic of the available land. A third position was chosen which, when the actual survey was undertaken, proved readily accessible and very satisfactory. If this advance information had not been available, a considerable expenditure of useless effort would have been made.

In spite of the fact that the photographs, whenever possible, are taken considerably in advance of the ground work they need not be retaken as the triangulation stations and signals may be plotted readily on them.

In using the aërial photographs for aiding the technical production of the desired chart slight variations in method are necessary due to the character of the different surveys. Less refinement is naturally necessary in the case of a running survey than that which obtains when the survey is of secondary or higher order or accuracy. The following method is, however, in general the one used.

In taking the aërial photographs, only the delineation and azimuth of the coast line and such topographic features as will be of as-

sistance to navigation are covered. Generally speaking, this means that the photographic flight is one closely paralleling the shore line. The overlap between individual photographs may therefore be increased without expense over that necessary in topographic mapping where the sides as well as the ends of the individual photographs must overlap. Between forty and sixty per cent overlap is the general rule. The plane flies at a certain specified altitude, up to the present time generally 10,000 feet, and the individual pictures cover an area of approximately one square mile. In the vicinity of triangulation stations the shore line is developed by ground methods for the distance of approximately one mile on each side. The result of this work is plotted on a field sheet at the desired scale. The aërial photographs covering this particular area are examined and the relation between the scale of the photographs and the actual area ascertained. From these photographs by means of a pantograph, set to give the necessary reduction, the coast line and other features are drawn on the field sheet. Then the photographs immediately adjacent to that overlapping on the area surveyed by ground methods are studied and three objects visible in both of these two photographs are located by measurement of the distance between these objects and the variation in scale between the two photographs may be discovered. The angles between the common points give the orientation of this second photograph. The photograph is then placed on the pantograph, the necessary change in the pantograph setting made and the shore line of this photograph is drawn and tied up with that obtained by ground method. This process is continued until the second triangulation station and its shore line is reached. With triangulation stations approximately five miles apart, sixty per cent of the shore line work is done by aërial photography. In the vicinity of the triangulation stations the coast is generally more accessible and this portion most adapted to development by ground methods. Thus the most difficult as well as the greater part of the shore line work is done by aërial photography. Frequently the coast line is so difficult of access that it could be done readily by no other known method.

Two features of this method might strike an observer accustomed to dealing with aërial photographs as unusual. First, no attempt is made to form a mosaic from the individual photographs, and second, no apparent attempt is made to eliminate the unavoidable errors incidental to aërial photography.

It is accepted by all who have had to do with aërial photographic surveying, that it is useful only in conjunction with ground controls obtained by the established methods of surveying on the ground, at least for really accurate work. Its greatest field of usefulness for the present appears to be for making preliminary reconnaissance and for filling in detail between control points. For these purposes it is without rival. One reason for this limitation of use is the fact that there are certain distortion errors liable to be present in the photographs which require some consideration.

The errors of distortion are as follows:

a. That due to the lens. This is circularly symmetrical about the center of the picture.

b. That due to the use of focal plane shutter. This produces a difference in the scale of the picture in the two directions parallel and perpendicular to the shutter travel.

c. That due to shrinkage or stretching of film or paper. This is usually circularly symmetrical and uniform for film, but unidirectional for paper.

d. That due to difference of elevation of the ground.

e. That due to lack of exact verticality of the optic axis of the camera.

Aside from these distortions or errors, the accuracy with which any point can be located on the ground is limited by the scale, the definition of the photograph, and the means used for measuring.

In all probability the tilt error causes the greatest trouble. Consider that the location on the ground of the point shown at the center of an aërial photograph is known. Then, unless the photograph was made with the optic axis of the camera accurately vertical, the apparent locations on the ground of other points as judged by their positions in the photograph will be in error owing to perspective distortion. The amount of the error for any particular point will depend upon the flying altitude, on the angle of tilt, on the focal length, on the distance, in the photograph, of the image of the point from the center of the plate and on the azimuth of the point relative to the direction of tilt. For given values of the first four variables the error is greatest for that azimuth which coincides with the direction of the tilt. The absolute error from this source is directly

proportional to the flying altitude. And, it is also increased with the increase of the angular distance from the optic axis, that is, the greater the angle of view of the camera.

The government specifications for aërial lenses give maximum allowable distortion of .08 millimeter per 100 millimeter focal length at eighteen degrees from the optic axis and .02 millimeter per 100 millimeter focal length at twenty-four degrees from focal axis.

Focal plane shutter distortion can be readily computed for any given set of conditions. Assuming a shutter with .5 inch wide slit giving an exposure of .01 second on an 18 by 24 centimeter plate, the travel will be approximately seven inches so that the time elapsing between the exposure of the first edge and the last edge will be about .14 seconds. If the plane is travelling at 100 feet per second (seventy miles per hour) it will have meantime gone fourteen feet and there will be fourteen feet of error in the relative apparent positions of the objects depicted near the edge of the plate.

The error due to shrinkage of film and paper stock is perplexing in that the error is not a constant; it will, in brief, vary with the particular lot of film or paper used. The shrinkage of film is approximately .5 per cent from all directions to the center; the shrinkage of paper stock varies from .5 per cent to 3 per cent and is almost always in one direction only, depending upon the manner in which the paper was flowed over the looms at the paper mill and upon the characteristics of the fiber from which it has been made. Uniform shrinkage in all directions of course produce no distortion, only a uniform decrease in scale. Shrinkage in one direction more than in another, however, produces an effect similar to the error introduced by the focal plane shutter. The absolute error on the ground will be inversely proportional to the scale and directly proportional to the size of the film.

The distortion due to difference of level of the ground or objects upon it is very much complicated by the presence of tilt distortion but for pictures taken vertically it is proportional to the difference of level and to the tangent of the apparent angular distance of the point from the center of the photograph.

These errors are eliminated or minimized by the following methods:

The lens distortion error is greatest on that part of the picture which is farthest from the center. The large overlap used insures that the parts containing the greatest errors are eliminated.

In the K 1 type of film camera the film is moving during exposure and if the camera is so set that this movement is in the same direction as the movement of the image on the focal plane, the error introduced by the use of a focal plane shutter is reduced to such an extent that it can be safely disregarded.

The shrinkage of the film being symmetrical results in a uniform decrease in the scale of the picture which is eliminated by the use of the pantograph, and the data obtained from the ground control. For the paper shrinkage, shrinkage tests are made on each lot of paper used and the error so determined taken into consideration.

The distortion due to difference of elevation is more difficult to deal with. Generally speaking, only the coastal area is photographed in the making of surveys by this office and with few exceptions the area so photographed has little or no elevation above sea level. In cases where the coast line is bold, special treatment will have to be given to the photographs but this problem has not yet been encountered.

With regard to the errors controlled by the pilot of the plane considerable progress has been made. The error introduced by difference of altitude at which the plane was flying at the time the photographs were taken is eliminated when the pictures are reproduced at a common scale by means of the pantograph. The tilt error which was and still is the greatest source of annoyance has been considerably reduced by the acquisition of skill on the part of pilots and by increased stability of the type of plane and camera mounting used. Experiments have shown that it is possible for the pilot of a photographic plane to keep the tilt in the direction of flight less than one-fourth of a degree. The tilt in the direction normal to the line of flight is hardest to control but the average error is less than one degree. As the coast line photographs are taken with the water line in the approximate center of the photograph and parallel to the line of flight the distortion of this line is very small. As yet, no errors which can not be adjusted when the uncontrolled coast line is tied up to that developed by ground methods have

been encountered and therefore it has not yet been necessary for this office to adopt any method of rectification or re-photographing of the pictures to eliminate the distortion due to tilt.

The development of instruments and methods of rectification of aërial photographs, stereographic means of determining contours and other new developments to increase the accuracy with which aërial photographs may be used in survey work are being studied with great interest. For the present, however, the method previously outlined is standard for this office and its opinion is that for the present at least more elaborate methods aim at accuracy greater than is justified considering the errors due to lens distortion and use of the focal plane shutter, even when these errors are reduced to the furthermost minimum.

Airplane Racing *and* Record Chasing

By LIEUTENANT F. W. WEAD, *U. S. Navy*

TOO MANY individuals, airplane races and record breaking flights are merely a spectacular form of sporting competition. Aviation, because of its novelty and hazards, naturally attracts much publicity. Normally, the greatest credit for a startling achievement in flying falls upon the pilot, while contrarily, failures are inevitably blamed upon poor material. The vast amount of research, study and experiment which must be gone through and the innumerable problems of design which must be overcome to produce a record breaking airplane are unknown and unconsidered by the general public in giving its praise for victory or its censure for defeat. It is obvious that material is as important and deserving as personnel and that, if material fails, personnel also fails. Any school boy can name a few of our well known pilots while the cognomens of aircraft engineers are apparently a carefully guarded secret, little known even in aviation circles.

Improved performance in aircraft is obtained to a certain limited extent, through improvements and refinements in existing designs. Beyond that point, radical innovations, new engines, or new designs are required. In striving for the ultimate, as in racing or in breaking world's records, it is only natural that every possible ounce of speed or other performance is desired and insisted upon. For this reason material, engines, fuel systems, propellers, radiators and the like and new refinements in design are frequently used in such aircraft without the benefit of thorough service trials; the only means of eliminating defects. Under normal circumstances, one cannot build a racing plane, test it for a year or two and still have it up to the minute and a keen competitor on the eve of the race. Progress in aircraft and engine design is far too rapid for such thorough and far-sighted preparation. It is for this reason that, despite the greatest care and highly skilled personnel, failures are bound to occur frequently when aircraft "shoot at the moon," and it is this uncertainty aside from comparative skill in design and in piloting that causes success to be a truly remarkable achievement.

The exigencies of the service are such that it may not always be possible to select the best personnel for any particular aircraft event. Then, too, there are usually various and varying ideas as to who the best pilots for any particular task may be. Several years ago the Bureau of Aëronautics was subjected to considerable criticism for using the same racing pilots two or three years in succession. It was maintained that there were many service pilots, equally skilled, who needed a chance to gain experience to demonstrate their ability. Subsequently it has been policy to train new alternate pilots each year, assigning them to actually compete the following year. This policy is highly desirable as it provides a considerable number of specially trained pilots and serves as an incentive for service pilots to become exceptionally expert for racing or other specialized flight work. It has been said that the most experienced pilots are not used in events of major importance. This objection holds true only in that rare instance when an alternate pilot is required to substitute for his principal. We may rest assured that the pilots selected for these tasks are, with few exceptions, well qualified for them.

RACING

The two principal airplane races in which the Navy has participated are the Pulitzer trophy for high speed landplanes and the Schneider cup for seaplanes. In these competitions specially built high speed racing planes are used. In addition, there is also the Curtiss marine trophy (seaplane) race for naval pilots and several minor events at the annual National Air Races in which various service types of aircraft are entered.

Competition for the Pulitzer trophy has been largely between the Army and Navy of the United States and it has been due

to the stimulus of this race alone that airplane speeds have increased so tremendously from year to year. From 1922 to 1925 the winner of the Pulitzer trophy was also the holder of the world's record for speed. Recently, however, France set a speed mark of over two hundred and seventy miles per hour which we have not yet equalled. From Major Bernardi's speed in winning the 1926 Schneider cup at Norfolk it appears certain that his Macchi-Fiat seaplane will further raise the world's speed record when fitted with wheels.

The Schneider cup has a history of keen international competition behind it that is second to no other trophy in existence. Since its inception in 1913, France, Italy, England, and for the past four years, the United States, have annually pitted the best of their pilots and seaplanes against each other. The rules for this competition provide that a country winning three times in five years becomes permanent possessor of the trophy. In 1922, when the cup seemed certain to fall to Italy through lack of suitable competition, Mr. Hubert Scott-Paine had designed and built the English supermarine *Sea Lion II* and, at his own expense, won a victory from France and Italy and returned to England with the "Flying Flirt," as the Schneider trophy is called. In 1923 as the victorious United States Schneider cup team was leaving England Mr. Scott-Paine assured "The Flirt" that she was only going for a very short visit. The sincerity of his words is evinced in the entry of the supermarine *S-4*, at Baltimore in 1925, backed by the British Air Ministry. Unfortunately, this plane was wrecked during the navigability trials. Many considered it to be the fastest plane entered in the race, which was won by Lieutenant Doolittle of the Army. In 1926, with two wins to the credit of the United States, and foreign competition three or four thousand miles away, it again seemed as though the Schneider trophy might become merely a decorative symbol of past achievement. We have witnessed, however, with regret perhaps, but also with admiration, Italy's clean-cut and well deserved victory last November at Norfolk.

To prepare to win a race of this sort far away from home factories and other facilities requires rare skill and determined effort. The Schneider cup is now gracing a pedestal in Italy but it may not stay there long. If the United States does not move it, France or England will, and next year and the year following will probably see the most intensive competition that this trophy has ever witnessed.

The present place of the United States among nations is not without honor and we cannot fail to keep a small portion of that honor bright by continuing to participate in the splendid sportsmanship and friendly rivalry which surround the Schneider trophy. It must also be admitted that such a competition not only provides knowledge of the activities of other nations and serves as an incentive in design but it also causes a scathing and often beneficial searchlight to be thrown upon all but the victor.

In preparing for airplane races, thorough planning and sharp execution are essential. Selection of pilots is vastly more important than socalled training, and, if the former is properly done, the latter is scarcely necessary. Early completion of the racing planes must be forced in order to provide ample time for tests and to have the planes completely ready for the event without last minute changes and hurried repairs or alterations which are conducive to carelessness and mistakes. Mechanics should be thoughtfully chosen and sent to the factories as the planes near completion. All the ground organization should be handled in such a way that each pilot is required to think of his own "ship" and of nothing else. Facilities for repairs and replacements must be available on short notice and if necessary carried out without confusion or delay.

World's Records

All the world's records for aircraft must be approved by the Federation Aëronautique Internationale before they are officially recognized as such. The F.A.I. is the parent body of all national aëronautic organizations and has its offices in Paris. Each country has a national club or society such as the Aëro Club de France, the Royal Aëro Club of England and the National Aëronautic Association in the United States, which is a member of the F.A.I. The F.A.I. sets down the rules under which races are conducted and which must be complied with if world's records are to be recognized. The local organization in each country sponsors the various race meetings to be held there and appoints the official observers for record breaking flights. Such

officials gather all necessary data which is forwarded to Paris in smooth form for analysis and approval. The F.A.I. is most rigid and severe in its requirements and any observations or records which are incomplete or the accuracy of which is in any way doubtful, are promptly rejected.

Eliminating airships and balloons, world's records are classified as follows:

1. Seaplanes and landplanes each in a separate class.

2. The principal records are: (*a*) speed (3 km. course), (*b*) altitude, (*c*) duration, (*d*) distance (air line), (*e*) distance (returning to point of departure).

3. Planes refueled in flight form a separate class for seaplanes and for landplanes.

4. There are separate speed records for distances of 100 km., 200 km., 500 km., 1,000 km., 1,500 km., etc.

5. There are separate records for altitude, speed, duration, distance, and for speeds over measured courses as outlined in (4) above for landplanes and for seaplanes carrying various inert loads, as: 250 kg., 500 kg., 1,000 kg., etc.

It will be seen that there are several hundred socalled world's records. Some of these minor records have never been established simply because no one has gone to the trouble of doing so. On the other hand, records have been established and stood for years because other flights which exceeded them in performance were not properly observed. For example, the seaplane duration record stood at about fifteen hours from 1924 to 1925 when it was raised to over twenty-eight hours by a *PN-9* at Philadelphia. In 1920, however, an *F5L* seaplane at Hampton Roads remained aloft over twenty hours, but this record was never recognized as it was not officially observed. Similarly, on the fifteen-hour flight referred to above, which was made over a closed course with observers at each turning point, a seaplane distance record of about 1,000 miles was established (returning to point of departure). This record still stands, despite the fact that on the twenty-eight hour flight of the *PN-9* at Philadelphia, at least 2,000 miles were covered, as this latter flight was not made over a measured course and hence the distance flown could not be observed.

A few years ago the United States held a large majority of the landplane and seaplane records of importance. Recently, however, the French government has offered substantial cash prizes to aircraft and engine manufacturers and to pilots for record-breaking flights. As a result, many records formerly held by the United States have gone back to France, which now holds the world's speed record and has made many landplane flights for air line distance in excess of 3,000 miles. Italy has recently gained or established a considerable number of seaplane weight carrying records with the Dornier Wahl and in the 1926 Schneider cup secured several new seaplane speed records. As a result, the latest report of the F.A.I. shows that France holds thirty-five of the seventy records now recognized. Great Britain does not hold a single record for any type of aircraft. Italy's total is now eight; Switzerland comes next with seven; Denmark holds four; Germany has three, and the United States has thirteen. All of Germany's records are for balloons and were achieved prior to the war. The duration record is eighty-seven hours, the distance record is 1,896 miles, and the altitude record is 35,424 feet, all of which is very fair for a lighter-than-air craft. The world's altitude record for airplanes is approximately seven miles or 40,820 feet. It is held by the French aviator, Callizo, and was established at Buc on August 23, 1926, in a Bleriot-Spad equipped with a 450 horsepower Lorraine engine fitted with a Rateau supercharger. France is credited with holding all the honors for gliders and helicopters. One Frenchman remained aloft in a glider for ten hours and nineteen minutes which is longer than most planes can stay up with an engine. (ED. NOTE: See p. XLVIII.

RESULTS

Aside from the spectacular and competitive elements which enter into airplane racing and record breaking, these attempts and achievements have had and will continue to have a most beneficial effect upon airplane and engine design and upon the morale of aviation personnel. This particular field of aviation effort has served as an experimental laboratory in which remarkable results have been obtained. When engines are driven at maximum power or aircraft at maximum speeds or to the greatest possible altitudes or are required to take off with the last possible ounce of load in an effort to establish new records for duration or distance, defects are searched out under a strain which

never occurs in normal service. In preparing an aircraft for such an effort improvements are tried which, if the effort were not made, might be long neglected. It has been clearly demonstrated in the past that the racing and record breaking airplane of today is, in many details at least, the forerunner of the service plane of tomorrow. To racing alone can we be thankful for such types as the Curtiss "Hawk" and the Boeing fighter—fighting planes second to none.

In many other matters in striving for ultimate performance valuable results have been obtained, viz.,

1. *Streamlining.* Propeller spinners, hidden or covered strut fittings, wing radiators, smooth and close fitting engine cowlings and various other refinements were first used in the effort to reduce resistance and to gain a few miles of speed in our Navy racers. While wing radiators because of their vulnerability are perhaps not suitable for service use, this study of radiator resistance has produced the streamlined tunnel type of radiator now used on our fighters. The other items mentioned above are directly reflected in current service design, resulting in increased performance and efficiency.

2. *Engines.* Once an airplane is designed around a certain engine any increase in engine power output will increase the performance of the aircraft. Power increase has been obtained largely by increasing the compression ratio of the engine and by increasing its r.p.m. Normal compression ratios are below 5.5 to one. At higher ratios detonation takes place with gasoline as fuel. A benzol-gasoline mixture prevents detonation and insures smooth running, but benzol, being somewhat heavier than gasoline, increases the total weight of the fuel load. While this is not of vital importance to racing planes it is very significant on duration flights, where every possible decrease in weight increases the ability to get off with a few more gallons of fuel. To overcome the extra weight of benzol and still prevent detonation various tetraethyl lead and alcohol and gasoline mixtures were successfully developed. These mixtures to a certain extent dictated the development of new types of spark plugs and high lift valve gear also became necessary to develop maximum power. As the r.p.m. of engines were increased from 1,800 to 2,500, steel backed main bearings, duralumin water jackets and stronger crank shafts and connecting rods were found necessary in various types in order to stiffen and strengthen the engine and to properly guard against failure. As a result of these improvements our present service engines not only deliver maximum power per pound of weight but also have a life of 250 hours or more between overhauls.

3. *Metal Propellers.* These not only have a greater factor of safety at high r.p.m. than do wooden propellers but also are more efficient, primarily due to the thin section at the tips. In some metal types the pitch can be readily varied as the blades screw into the hub; in other types the pitch can be varied by bending the blades. This is a further advantage. It is believed that metal propellers were first given a thorough comparative test against wooden propellers in testing the Navy racers which entered and won the Schneider cup at Cowes, England, in 1923. In one instance it was found that with the metal propeller at a certain pitch setting the engine turned about two hundred r.p.m. more than with the best wooden propeller and gained some ten miles in speed. A certain amount of this increase in speed must be allotted to the increased horse-power at the greater r.p.m., while the remainder is due solely to the greater efficiency of the metal propeller. Metal propellers are now in general service use.

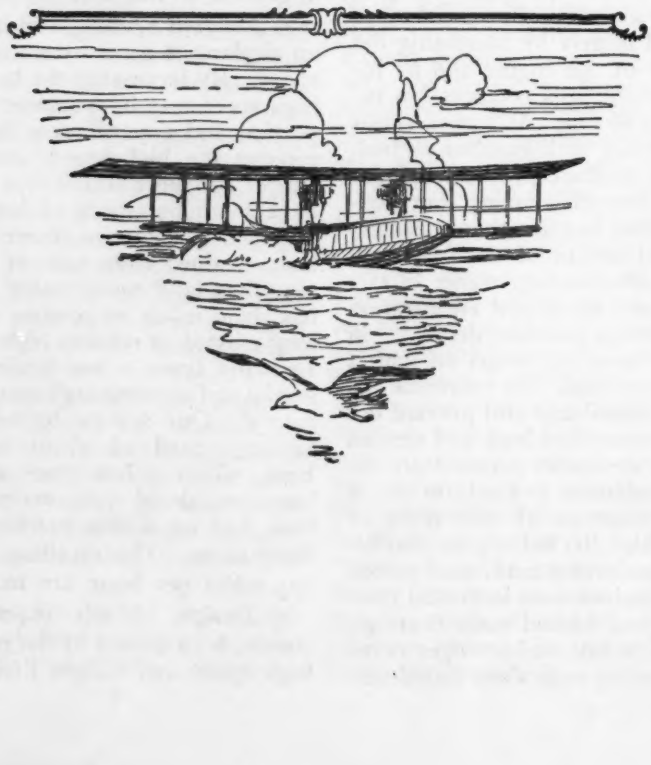
4. *Landing Speeds.* The landing speed of an airplane to some extent governs its high speed. By increasing the landing speed the high speed may be increased in greater proportion and any decrease in landing speed reduces the high speed accordingly. The entries for the Pulitzer race are required to have a landing speed of less than seventy-five miles per hour as shown by wind tunnel data obtained from tests of models. Actually, they land considerably faster. Racing has done much to remove the fear which long existed as regards high landing speeds. In many types a low landing speed is essential and extreme high speeds are not mandatory. Our service fighters now have a landing speed of about sixty miles per hour, which a few years ago would have been considered quite excessive, and pilots have had no difficulty whatsoever in handling them. The resulting high speeds of 175 miles per hour are most satisfactory.

5. *Design.* Much experience has, of course, been gained in the general design of high speed and weight lifting aircraft and

in the development of suitable wing sections for them.

6. *Long Distance Flights.* In increasing the cruising range of aircraft and in attempting long distance flights many of the changes outlined above have been developed and applied, particularly as pertains to engines, fuels, streamlining, propellers, and increased fuel economy through a study of economical speeds under varying loads and proper use of the mixture control. Metal construction has been developed and experience has been gained in carrying and getting off with maximum useful loads without sacrificing the strength or factor of safety of the airplane. Navigation and radio material have received a decided stimulus.

In general, if our government has ever received full value for funds expended in any effort it has entered upon, it has received many times full value in the results obtained from past naval experience in racing and attempting record breaking flights in aircraft. While the lack of world's records or the inability to win races at any specific time does not necessarily prove that the service air forces of the nation are inferior or at a low ebb, it seems certain that this is the case over a period of years. Experimentation costs money which is often difficult to obtain. The results of a spectacular experimental achievement which may startle the world at a given instant are usually not felt in service aviation for at least a year and probably longer. That country which leads in spectacular flights will subsequently lead in service aviation and that nation which no longer feels the urge to compete with others has passed its peak. The Bureau of Aëronautics has every reason to feel proud of its past record, which has placed and maintained our naval aviation second to none. We must go on, else we go back.



Air Operations *in* Palestine

By LIEUTENANT FORREST SHERMAN, *U. S. Navy*

DURING the late summer and the fall of 1918 the attention of the United States was more or less concentrated on the progress of events on the western front. Yet during the month of September when the Allied forces in France were commencing the last great offensive in that theater of war, the Egyptian Expeditionary Force under Allenby was achieving a victory over the Turkish arms which had a stupendous influence on the war as a whole, and the importance of which may not be fully realized. By the crushing blows which were dealt the Turkish Army the submission, not only of Turkey, but also of Bulgaria and Austria was hastened, and Germany was left alone to face the ever increasing Allied pressure in Europe.

In any case, the last six weeks of the campaign in Palestine and Syria, while perhaps lacking the sentimental appeal of the operation leading up to the taking of Jerusalem in the previous December, are worthy of the closest study from the military point of view because of the superb coöperation manifested between the component parts of the force including the Palestine brigade of the Royal Air Force. By his employment of his splendid force of cavalry, the desert mounted corps, Allenby taught the world that, despite its relative unimportance in France, the mounted arm was still a potent factor in war. The campaign also showed that, instead of the air force replacing cavalry, it in fact had enhanced rather than decreased the value of a highly mobile mounted force.

Colonel A. P. Wavell, formerly brigadier general of the General Staff, with the Egyptian Expeditionary Force, in discussing the campaign and its lessons, states:

> These campaigns of the Egyptian Expeditionary force are of great strategical interest. For the military student they will always remain classic examples of the use of mounted troops and of the value of mobility. Conditions of war change, and it may be that some mechanical form of transport will entirely replace the horse as the means by which mobility can be secured. But the power of mobility as a strategical weapon, in the hands of a commander who has the knowledge and the determination to use it as did General Allenby, will only be enhanced. A second strategical lesson is the advantage gained by a commander who can conceal his intentions from his opponent.

During the last few years the phrases "control of the air" and "air supremacy" have been used many times, but it is doubtful if there has existed in any campaign a more striking example of veritable control of the air than was furnished by the situation in Palestine in September, 1918. The air supremacy at that time achieved by the Palestine brigade, R.A.F., under Brigadier General A. E. Borton was so complete as to render the enemy air service practically useless while the British command at all times realized to a remarkable degree the advantages of an effective aërial information service, of absolute security against enemy reconnaissance, and of the free use of an offensive arm of splendid efficiency. In the words of the *Official History of Australia in the War,*

> The airmen, daily growing bolder as their supremacy became clear, by August completely dominated the German pilots, ranged incessantly over the enemy's territory, and by their aggressive and thorough system of defensive patrols kept the British lines and rear almost entirely free from aërial observation.

After the capture of Nazareth the war diary of the German air detachment was found, and in it one reads a record of failure and defeat in phrases such as: "Owing to the extraordinary lack of pilots, limited flying only can be carried out, in spite of the arrival of twenty new D.F.W.'s," and in references to a scarcity of pilots "owing to sickness and *other causes.*" The "other causes" were the bullets and bombs of the British aviators who had been forcing the fighting and decimating the German formations by continuous, vigorous offensive tactics.

Schuz, who commanded one of the German squadrons in Palestine, mentions some

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of the logistic difficulties experienced by the German air units in maintaining themselves far from an adequate base and in endeavoring to carry on with a minimum amount of aviation material. He says:[1]

> The forces at our disposal had been decimated by a terrible famine, brought on by Turkish indolence and the bitter feeling among the population of the country, who were no longer cultivating their fields, owing to the vigorous system of requisitions. Numbers of horses, camels, mules, and donkeys were lost, and the result was a catastrophic disorganization of our transport system. It was in vain that the German airmen fought with the courage of despair; it was in vain that they used to fly across the lines in the face of eight or ten times as many hostile machines, for which, day and night, petrol and other necessaries were being provided, as well as for their mechanical transport.
>
> At the very last moment our squadron broke away from the enemy, and, since their retreat to Aleppo was cut off, arrived after infinite trouble by way of Mardin, Malatia, Sivas, and Amasia at Samsun on the Black Sea.

At the beginning of the offensive of September 19, 1918, variously referred to as the Battle of Sharon, of Nablus, or of Armageddon, Allenby held a position running from the Mediterranean coast north of Jaffa easterly through the Judean hills south of Nablus to the River Jordan, and south to the Dead Sea, including bridgeheads east of the Jordan at Ghoraniyeh and Aujah. His forces included approximately eight divisions of infantry and four of cavalry, comprising 12,000 sabers, 57,000 rifles and 540 guns. Opposed to him were ten Turkish divisions, some 1,200 cavalry, and six German battalions; the whole estimated at about 4,000 sabers, 32,000 rifles, and 400 guns. The exact Turkish strength is difficult to determine since in spite of Allenby's estimate given above, and General Liman von Sanders' figure which is smaller, 75,000 prisoners were taken in the subsequent British advance.

The British air strength was as follows:

Fifth Wing—(Assigned to Corps Command)—

No. 144 Squadron, RAF. *RE-8*, Corps, reconnaissance planes.

No. 113 Squadron, RAF. *RE-8*, Corps reconnaissance planes.

No. 142 Squadron, RAF. *RE-8*, Corps reconnaissance planes.

Fortieth Wing (Operating directly under GHQ)—

No. 111 Squadron, RAF. *SE-5* Single-seater fighters.

No. 144 Squadron, RAF. *DH-9* Light Bombers.

No. 145 Squadron, RAF. *SE-5* Single-seater fighters.

No. 1 Squadron, AFC. Bristol Fighters (Biplane), One Handley Page heavy bomber.

Balloon Company.

The German air strength comprised Nos. 301, 302, 303, and 304 Squadrons of the German Flying Corps equipped with D.F.W.'s, Albatross and Pfalz single-seaters, and A.E.G. two-seaters.

The British plan of battle was to secretly concentrate a striking force of some five infantry and three cavalry divisions in the coastal plain of Sharon, break through the strong Turkish defenses in that sector, and then move the Mounted Corps through the gap cleared by the infantry to operate against the Turkish rear and communications and cut off the enemy lines of retreat to the northward. It is evident that the success of this plan depended on secrecy during the period of concentration. This secrecy was to be achieved by camouflage, by moving troops at night, and by the maintenance of security from enemy reconnaissance by a continued offensive in the air.

In Lord Allenby's dispatch of October 31, he stated:

> The chief factor in the secrecy maintained must be attributed however to the supremacy of the air which had been attained by the Royal Air Force. The process of wearing down the enemy's aircraft had been going on all through the summer. During one week in June 100 hostile aëroplanes had crossed our lines. During the last week in August this number had decreased to eighteen. In the next few days a number were shot down, with the result that only four ventured to cross our lines during the period of concentration.

During the summer the British patrols were maintained and a most determined offensive carried out against the German air units both in the air and at their airdromes. In addition, four hundred square miles of country were mapped for the coming offensive. The last determined effort of the enemy at offensive reconnaissance was on August 24, when a German patrol of two LVG two-seaters and six Pfalz single-seater scouts crossed the British lines near the coast. It was attacked by an Australian flight of Bristol fighters and was beaten off after four German machines had been shot down. Only one of the German airplanes was able to reach its airdrome after the fight. From that time on German attempts at reconnaissance of the areas be-

[1] *The German Air Force in the Great War*, Neumann.

hind the British lines were limited to single machines at high altitudes except the one case of two LVG's which were shot down in company on August 31. During the first two weeks in September the British airplanes made the most of their opportunities for attacking men, animals, and material on the ground and yet, so consistent and sustained had been their harassing activity, the imminence of the coming offensive was in no way disclosed. During the eight weeks preceding September 19, the Australian squadron alone shot down fifteen enemy airplanes.

The detailed plan of air operations for the coming battle allotted tasks as follows:[2]

Squadrons of corps wing to operate with corps to which assigned and bomb objectives immediately behind the enemy lines.

Nos. 111 and 145 squadrons (single-seater fighters) to maintain continuous patrol over the Jenin airdrome all day, prevent any attempted enemy air action from that quarter, and to attack with guns and bombs all targets in the vicinity.

No. 144 squadron (day bombardment) to maintain bombardment of El Afule railway station and Turkish headquarters at Nablus.

No. 1 squadron (two-seater fighters) strategical reconnaissance and bombardment.

By sundown on the eighteenth all preparations had been completed. The divisions detailed for the attack, the 60th, 7th, 75th, 3d, 54th, and the French contingent, were in place, while the 4th and 5th Cavalry Divisions and the Australian mounted division were concealed in the orange and olive groves north and east of Jaffa.[3] The British airplanes were in readiness at their respective airdromes. The Turkish command was still in ignorance of the concentration which had been effected.

At 1:00 A.M. September 19, the Battle of Sharon was opened by the departure of the Handley Page bomber from the Ramleh airdrome on the first bombardment mission. It placed sixteen 112-pound bombs on the objectives at El Afule and later in the night thirty-two 112-pound bombs were dropped on the Turkish Army Headquarters at Nablus and Tul Keram. The effectiveness of these raids is shown by the fact that when the British cavalry reached El Afule, which was the center through which all communications from the Turkish GHQ at Nazareth ran south, it found that the bombardment had wrecked practically every wire and had almost completely isolated Nazareth from the front. The broken ends of most of the important wires were found in one or two bomb craters. Two hits were made on the communication center at Tul Keram and the building which contained the signal headquarters at Nablus was blown to pieces. As a result of this early action the Turkish Fourth Army in the Jordan Valley was at noon on the twentieth left still in ignorance of the disaster which had befallen the right flank nearer the coast. The GHQ at Nazareth was, of course, immune from bombardment, but its isolation was equally effective. Throughout the forenoon the same objectives were bombed at intervals by the DH-9s of No. 144 squadron.

At daylight the first patrol of two SE-5 single-seater fighters equipped with fragmentation bombs arrived over the Jenin airdrome for the purpose of destroying or keeping out of action the eight single-seaters and three two-seaters of the German air squadron at that place. From dawn until dusk this patrol was maintained and it was most effective. The German pilots remained in their dugouts, any movement toward the hangars being met by a bomb and a burst of machine gun fire. At the end of each hour and a half relieving machines appeared and the retiring patrol dove down, emptied its bomb racks and magazines into the hangars and dealt out general destruction.

The initial infantry attack was a complete success. By noon on the nineteenth the Turkish resistance in the coastal area was broken and under the combined pressure from the infantry attack, the gunfire from the artillery assisted by the guns of the *Druid* and *Forester,* and the advance of the cavalry, the Eighth Turkish Army was soon in full retreat toward Tul Keram. That night the British center commenced its slow advance through the rugged and difficult country which was strongly held by the Turkish Seventh Army.

The Fifth British cavalry division crossed the Plain of Esdraelon, reached Nazareth and captured the headquarters and part of the staff of General von Sanders, together with 2,000 prisoners at 5:30 P.M. on the twentieth but Von Sanders personally was able to make his escape. By 4:30 A.M. of the same day, the cavalry were in possession

[3] *Official History of Australia in the War of 1914-18.*

[2] *Official Record, Egyptian Expeditionary Force.*

of Beisan, Jenin, and El Afule, and the escape of the Turkish Seventh and Eighth Armies had been shut off by all routes except the road from Nablus southeast to the Jordan at Damieth.

In the meantime, the Bristol fighters of the Australian (No. 1) squadron, in addition to their reconnaissance duties, used their guns and bombs on the targets available and acted as escorts to the bombardment operations of the De Havilands of No. 144 squadron. A patrol of three Bristols found the road to Tul Keram crowded with retreating Turks, including 2,000 horsemen, 5,000 infantry, and some 600 pieces of transport. They dove down and loosed into this mass some 2,000 rounds of gunfire and emptied their bomb racks. On their return organized bombardment of the Tul Keram road was commenced, the first attack being delivered at 11:40 A.M. by a formation of five airplanes and the second at 12:30 P.M. A third attack by six airplanes was delivered to the west of Tul Keram where the routed enemy pressed into the road to Nablus in a confused mass. This road leads through a narrow defile and formed a trap in which terrific destruction fell upon the retreating column, while individuals who escaped into the hills on either side were soon taken prisoner by the advancing British cavalry. At this point two planes were shot down by the Turks but the pilots were rescued by the pursuing cavalry who, at this time, took fifteen guns and 2,000 prisoners. At about 5:00 P.M. another formation of seven airplanes again bombed the column with great effect. During the afternoon and evening the bombardment of the Jenin airdrome continued and by nightfall it was a rubbish heap.

By the morning of the twentieth, the roads leading north from Samaria and northeast from Nablus were crowded with fugitives while the British cavalry was closing on El Afule from the west. Air reconnaissance east of the Jordan found the Fourth Turkish Army apparently still unconscious of events to the westward.

The air operations of this day consisted of continual bombardment of the retreating enemy, reconnaissance and contact patrols for the benefit of the infantry and cavalry units, and artillery coöperation. In addition operations against the German airdromes continued. Bombardment and machine gun attacks centered about the Samaria-El Afule and Nablus-Ferweh roads.

At dawn on the twenty-first a patrol of two Bristols found the Turkish Seventh Army in full retreat along the road from Ferweh eastward to Ain Shibleh and thence northeast toward the Jordan. It was necessary that this force be broken up since, although escape via Beisan was prevented by the position of the Fourth cavalry division, the road across the Jordan was still open. A prompt report was made by radio and then commenced the most terrific slaughter of troops ever effected by airplanes. The history of war does not afford a more striking example of the destructiveness of the air arm when afforded freedom of action by an absolute supremacy of the air.

The Brigade Headquarters arranged that two bombers should pass over the Ferweh road every three minutes, and an additional flight of six airplanes each half hour. For this work every airplane available from all squadrons was used. The bombardment was delivered from a height of about two hundred feet in spite of the fire of rifles and machine guns and only two airplanes were shot down.

By noon some six tons of small bombs and 44,000 rounds of machine gun fire were accurately placed among the fleeing guns, wagons, infantry, and cavalry. Men fled and attempted to scale the precipitous banks of the defile and horsemen streamed down the road to the Damieh ford, but for the unfortunate animals there was no escape and the panic became general. Some vehicles were dragged over the cliffs by the maddened draft animals. The road was completely blocked. Officers and men were shot down, trampled on, or escaped into the hills.

An eye witness, Mr. W. T. Massey, describes the scene as follows:[4]

> I did not see the road until the next day. It was horrible.
>
> Thousands of dead animals already made the air offensive. Horses, oxen, mules, and donkeys had met sudden deaths as they stood anchored in that long drawn out column of transport. . . . .
>
> There was scarcely anything standing on wheels except guns and not all of these had survived the bombs. . . . . A whole army's papers were distributed to the four winds.

General Allenby later reported[5] that on five miles of this road, eighty-seven guns, fifty-five motor lorries, and 842 other vehicles were found, while the task of caring for

[4] *Allenby's Final Triumph*, W. T. Massey.
[5] Despatch of October 31.

the surrendered Turks had become a difficult one.

On the twenty-first, Colonel Lawrence, the leader of the Arab Army operating along the Hejaz railway, was at his request brought by air to Ramleh and reported that the German airdrome at Deraa was proving to be a veritable hornet's nest. Its planes had bombed his headquarters several times during September 18 and 19, had destroyed both of the two old airplanes with his force, and had greatly lowered the morale of his Arab auxiliaries. Three Bristol fighters were sent back immediately, followed by the Handley Page bomber which acted as a transport for fuel and supplies. In the next two days, the German squadron at Deraa, consisting of three Pfalz fighters and a number of DFW's, was completely wrecked by air combats and the bombardment of its airdrome. It operated no more.

During the following weeks the operations of the Palestine brigade continued but decreased in magnitude as the Turkish resistance collapsed. By October 1, the Egyptian Expeditionary Force was in undisputed possession of Damascus and Acre and the Turkish power in Syria was completely broken.

The operations described are peculiarly interesting because they illustrate so clearly and forcibly the possibilities of the use of air forces against a retreating enemy and against enemy communications, and the dependence of air operations upon proper logistic provisions, but chiefly because they show the inestimable value to a surface offensive of supremacy of the air. Perhaps the most outstanding lesson of the whole operation is the fact that this absolute supremacy was won, not only by offensive fighting in the air, but also by continued operations against the enemy airdromes. It seems to be almost axiomatic that the most effective way to destroy an enemy air force is to conduct offensive operations against its bases. If this be true on land, it is even more true at sea, where airdromes are limited to the decks of a few vessels of most vulnerable characteristics.

Air Mapping *in* Haiti

By First Lieutenant Hayne D. Boyden, *U. S. Marine Corps*

(See pages xxxvi, xxxvii, xxxviii)

THE inception of aërial photography as an aid to mapping in Haiti arose from the desire of the Travaux Publics to secure as quickly as possible an accurate map of the Artibonite Valley. It is the largest single valley in Haiti, the most fertile, and the best adapted to irrigation as the largest river in the republic runs through one side of it. After bringing down silt for centuries, the river has gradually raised the land through which it flows until its course is now higher than the rest of the valley. The valley was intensively cultivated and partially irrigated by the French in colonial times. The long, straight and, in many cases, parallel roadways and section lines covering the valley today like a network, show the thoroughness of the colonists' work. Now the valley lies dormant, grown to seed, yet with many little cultivated patches, scattered about here and there, with clusters of huts near by. There is a sharp contrast between the overgrown roadways with their jungle slothfulness, and the white man's thrift and orderliness.

There are several methods of surveying territory by means of aërial photography. One is to estimate territory by oblique photographs which consists in exposing a succession of pictures obliquely over the side of the plane, and at the same angle and with parallel axes. From a computed scale the area covered by each picture is found. This method, for example, is used for estimating the amount of timber in a given area in heavily wooded sections of country.

There is another type of map which gives a fairly complete idea of a section of country but which is not absolutely accurate, made where large expanses of territory must be covered in a limited time. This map is made with a tri-lens camera. One of the lenses photographs vertically while each of the others takes a picture at an angle of about sixty-five degrees. All three are taken at the same time through the bottom of an airplane, with the axes of the lenses in a plane perpendicular to the surface of the earth. Fairly accurate vertical pictures are obtained from the two oblique negatives, and by means of a special printing machine, the tilt is taken out of the picture to a great degree. However, there is quite a little distortion in these two outside pictures, and when the prints are laid, successive strips do not match very well on this account. This camera has the advantage, in addition to its ability to take three pictures at a time, of covering a considerable area in each flight. The Alaskan Aërial Survey was made with this type of camera and furnishes a good example of the use to which it may be put.

Finally, there is a type of map which is produced by taking vertical pictures with a single lens camera of sufficiently long focus to practically eliminate all distortion. With this type of map it is possible to have an accurate scale, all prints match, even at the extreme edges, and the finished product is so exact as to satisfy the rigid requirements of civil engineers. It is easily seen from the above that this last type of map requires a greater amount of time to take and prepare than does either of the other two.

It was this kind of map that the naval and civilian engineers required for their work in Haiti. The problem of obtaining it was rendered all the more difficult by the fact that no control data could be furnished as a means of checking the accuracy of the maps which were laid from the photographs. Thus the Republic of Haiti was a ripe field where aërial mapping could prove its value, as practically no maps existed, either of the plains or of the roads. Maps that could furnish contour lines, roadways, section lines, boundary lines of property to aid cadastral surveys, river courses, and other data were greatly needed.

Mapping by means of aërial photography

is done by taking successive pictures of the surface of the earth as it passes beneath the airplane. In covering a given area, a number of lines of flight are necessary, each being made parallel to the last and at the same elevation as nearly as possible. The pictures are taken at such intervals during any one line of flight that each one covers half of the area in the preceding one, thus giving a 50 per cent overlap. This is a good average overlap, though more or less is often made, depending upon the mission. The successive lines of flight also should be flown so that a side overlap of 50 per cent is obtained in the resulting strips of prints. In taking the pictures, the observer makes an exposure, then waits a given number of seconds, depending upon the given altitude, speed of the plane and the wind velocity and direction, before making another, thus obtaining the required amount of overlap.

The photographic pilot and observer must act as a team if good results are to be obtained. Some work together is necessary for each to become thoroughly familiar with the other's peculiarities. Many little difficulties arise continually, and if these are not mutually understood, and either anticipated or immediately corrected, they can easily prevent the mission from being successfully completed.

In the aërial mapping of Haiti the K-3 camera was used. It is the belief of the writer that this is the best mapping camera that has been developed up to the present time. It gives a clear-cut picture out to the very edge, which some other cameras do not do. The film used comes in rolls seventy-five feet in length and ten inches wide. Practically all of the work in Haiti was done at ten thousand feet, and at this elevation one negative on this film covers over a mile in length and a mile and a half in width. Several magazines may be carried on a single flight, or the film may be reloaded in the air, using only one magazine.

To obtain clear pictures at this, or any efficient working altitude, it is absolutely necessary to use a quality of film that allows the use of a filter so as to cut the haze. The strength of the filter depends on the density of the haze. If a filter is not used, or the film used cannot take a filter, the resulting pictures will be flat and hazy in tone, not showing anything with clarity or sharpness. The filter is simply a piece of stained gelatine of some degree of orange color and is placed between the elements of the lens.

Most of the exposed films had to be developed in Haiti at night when the air and water were coolest. The film is developed in the full seventy-five foot lengths by means of a special developing outfit. The film is first wound integrally within a celluloid apron on a reel, which is then placed in a twenty-gallon tank of developing solution. This tank has a water-tight cover, and, during the half-hour period of development, it is turned on its pivoted axis about once a minute, thus insuring the solution's reaching all parts of the film evenly. The film is then passed into the usual fixing bath and later washed for an hour. All of these processes are carried on in twenty-gallon silver-lined tanks. By handling the film in this way the finished roll comes out unscratched, or otherwise blemished, and is evenly developed. After washing, the film is wound on a large drying reel, from which it comes ready for numbering and printing.

The printing machine is a contact one, the paper being laid on the negative and pressed on by a lid while light is turned on beneath the film. This printer was developed specially for handling mosaic film. It is very complete, having a pneumatic cushion on the under side of the lid to press the paper evenly and surely over the whole negative and an electric blower to dissipate the heat from the nine lights in the printer. It has special holders for the spools holding the film during printing and separate switches for each of the nine lights, so that some may be turned out under an uneven negative to make an even print.

In laying a mosaic map from a number of prints, a completed map is desired that looks like one picture of the area covered and not like a crazy quilt with any number of shades and tones where the different prints are joined. For this reason great care must be exercised in order to obtain the same tone on all prints going into a mosaic map. A light French blue-grey is preferable and copies best. In laying the mosaic, a print is first covered with an adhesive, preferably gum arabic, and then laid on the base for the map by wiping it down with a piece of wet cotton, beginning at one side of the print and gradually working across to the other edge. This eliminates air bubbles which otherwise would form under the print and cause bulges in its sur-

face. The next print is then taken up and studied carefully, with reference to the territory on it that is covered by the preceding print. Let us say that it overlaps the first print 50 per cent. There is on it half of the area covered by the one already down. This means that we can cut away and discard at least half of it. The cut is made just beyond a roadway, fence line, hedge, river course, or any other natural break in the terrain in order to make the dividing line as nearly invisible as possible. The cut is made with a razor blade, and only half way through the paper. The part to be discarded is torn back and under the part to be retained so as to form a beveled edge. This edge is then sandpapered to a feather edge, and after the adhesive is applied, is laid over the first print, covering exactly all of the territory that is identical to each. The reason for making the cut beyond the hedge or roadways, and keeping it on the part retained, is that greater accuracy may be secured by having the line or object on the second print to lay directly over the like line or object on the under print. Print number three is then cut and laid down on number two in like manner and so on until the end of the strip is reached when the adjoining one is begun. In this way a map which is truly a mosaic emerges from the prints.

Aërial mosaic maps have been put to a very practical use in Haiti by the Travaux Publics. For a given plain they have made use of them in the following ways. From the film, one set of prints was made for laying into small mosaics, plane table sheet size, that could be used in the field; a set of prints was made for use under the stereoscope to be used in the field areas in connection with the small mosaics, and another set of prints was made for laying into a large mosaic to be retained in the laboratory for copying and for reference.

The small mosaics and stereoscopic prints proved to be of great value in the field, where they saved the engineers untold labor and time. The country in which they were working was tropical and hot, with jungle undergrowth which left the trails barely passable. Even on horseback they could not know what was on the other side of the thick cactus hedges bounding the road or trail. There were no knolls from which to make sights. But with the small mosaic of the area in which they were working, and by use of the stereoscope with the extra set of prints, they could see the whole terrain. They could know what to expect ahead on the trail they were following, which way to turn at a fork in the trail or road to bring them to the desired destination. As one engineer said, "With two of these prints under the stereoscope, I can more accurately trace the contours, roads, rivers, streams and section lines in fifteen minutes, than I could possibly do in a whole day by tearing my way through the bush." One print covers an area a mile and a half square and by using the one before and after it under the stereoscope, all of it can be quickly covered. The engineers have from one to three known elevations that they have brought up from the previously worked area to the present one. Under the stereoscope they trace the contours through these points, and then fill in the others in proportion, judging the heights from what they can see between the known elevations.

After the required data is placed on one print, it is retraced on the like print in the small mosaic. Thus as the data is gradually secured from each print and placed on the mosaic, the mosaic soon has all the required information on it for the section of country it covers. Tracings are then made from the small mosaics until a complete contour map is had of a whole plain or valley.

The stereoscope mentioned above is of such great value when in mapping with prints, that it deserves a word here. During the last war the stereoscopic principle was used and to great advantage, but with the old time stereoscope with which every one is familiar. It was used as follows: Mapping prints must have overlap to qualify as such. Therefore they are similar to two pictures taken with a huge camera having two lenses half a mile apart, for example, the distance between positions of the plane at the time of each exposure. All prints with overlap have potential stereoscopic value, which is to say that all the area identical to each may be viewed in strong relief with a stereoscope. When any part of a mapping print was to be viewed with the old type of stereoscope, it was first necessary to decide what part of the print possessed military information. Then this portion, say two inches square, was cut from each of the two prints and pasted on card board two and a half inches apart (the average distance of the human eyes). Then this card was slipped into the rack on the old

stereoscope and everything in the little square of the picture stood up in relief.

This system had many disadvantages. There was the delay incident to preparing the parts before they could be viewed, the restricted area that could be seen at one time, and the probability of making a poor decision in the part cut out. Good camouflaging of a position or road would enable it to pass unnoticed.

All of these disadvantages disappeared at once with the advent of this new stereoscope. It was brought out by the same firm that makes the K-3 camera and it is of inestimable value from a commercial and military standpoint. When mapping prints are viewed with this stereoscope all that is necessary is to place the two prints about a foot apart on the table on which it rests. Then with a little shifting for correct position, all of the country identical to each print immediately jumps up into strong relief, amazingly sharp and clear. On prints taken at ten thousand feet elevation, the differences in relative height between the upper and lower branches of a tree and the ground can readily be noticed.

As the smallest depression or rise in the ground shows clearly, it can be seen at once how rapidly a given section of country could be covered in this way. The camouflage over a road or position cannot hide it for it will be seen standing up over the road like a flat roof twenty feet high and the artillery can be trained on it at once.

The simplicity of the construction and use of this stereoscope is marked. It consists of a fairly heavy base supporting a horizontal bar a foot above it. In the middle of this bar two and a half inches apart, are two small mirrors an inch and a half by two inches in size, placed with their faces up, but tilted outboard at a forty-five degree angle. At each end of the bar, a foot away from the small mirrors, are two large mirrors, also placed at an angle of forty-five degrees. The large mirrors face downward and inboard, so that each little mirror faces each large mirror. A horizontal line would pass through the center of all of the mirrors.

To use the stereoscope the prints are placed approximately under the large mirrors, which pick up the image of each print. Then one looks down into the small mirrors, with the eyes very near them, and in each sees the image in the large mirror. This gives the relief illusion, the principle of the stereoscope.

The kind of mapping described above has been done for the Travaux Publics of Haiti for the last two and a half years by Observation Squadron Two, the Marine Corps Aviation Unit at Port au Prince. The work began with the Artibonite Valley job and the results attained were so satisfactory to the naval officers of the Travaux Public, the American high commissioner and to the president of Haiti that they desired further mapping. Therefore, as rapidly as the photo officer and two men could furnish them, these mosaic maps were made. It took all of the men's time developing the film, making the prints, and performing the incidental work necessary for the maintenance and operation of a mosaic laboratory. Whenever favorable flying weather for mapping occurred, the pilot and one of the men would have to drop everything and go.

During the above mentioned period, all of the valleys and plains of Haiti, except the inland plain not potentially irrigable, all of the roads, several of the rivers, and some special projects, were mapped. The areas mapped equalled over two thousand square miles, and the roads a thousand miles in length. Including the field maps, over four thousand square miles were laid in mosaic. Over eight thousand negatives were exposed, and from these about thirty-five thousand prints were made. All of these areas were laid into large maps and copied. Field maps were made of most of the areas and stereoscopic prints were furnished. All areas desired were mapped. Large maps of the Northern Plain were not made, the field maps of a third were furnished, and several areas laid twice. Only a few stereoscopic prints of the road maps were furnished up to the middle of April.

The photographic officer laid all of the mosaics, except some of the small field maps of the Artibonite Valley and a few of the road maps that were not completed when orders were received transferring the photographic officer and one photographer to Nicaragua.

DISCUSSION

Adventures of "Old Glory"

(See page 318, March, 1927, PROCEEDINGS)

CAPTAIN EDWIN T. POLLOCK, U. S. NAVY (Retired).—The article "Adventures of Old Glory" gives some noteworthy events in its history, and some side lights on other flags carried by our forces.

This article is a side light as viewed literally from the seaward side by one of Sampson's ships and is a correction to that part relating to the "American flag raised over Santiago," in which the inference can readily be made that our flag was hoisted over the Morro at Santiago at noon, July 17, 1898, the hour it was hoisted over the Palace in the city of Santiago.

A very few days before Cervera's fleet came out of Santiago harbor, while the officers and crew of the *New York* were assembled on the quarterdeck for the usual evening prayers, the chaplain changed his prayer for victory by asking for *"a very speedy* victory," and electrified us all by his emphasis. The speedy victory soon came. Then there were two weeks of impatient waiting for the formal surrender of the city and the hoisting of the American flag on the one remaining flagstaff on the Morro. (The other flagstaff with its large Spanish flag had been shot down by the *Oregon* during the bombardment on July 2, and part of the staff could be seen hanging down the cliff. On July 1, the *Suwanee* had shot down the flag at Aguadores.)

It had been announced that the Spanish flags would be hauled down at 9:00 A.M., July 17, and the American flags would be hoisted at the Palace and the Morro at noon.

The Spanish flag came down on the Morro at 9:04 A.M., and at noon the *New York,* the *Brooklyn,* the *Indiana,* the *Gloucester,* the *Vesuvius* and the *Vixen,* were waiting impatiently for an American flag to be raised when a national salute would be fired by all of our ships. We were more impatient as the minutes passed with no flag over the Morro. One o'clock passed, and then two o'clock when it was concluded that American flags were scarce on shore, so the saluting guns were secured.

A look-out was still kept on the Morro, however, and about half past two a small American yacht ensign crawled slowly up the flagstaff from which the Spanish flag had disappeared over five hours before. The psychological moment for a salute had passed, however, and none was fired, but we were pleased to see our hopes for weeks partially realized.

The next morning a regular American flag appeared on the flagstaff. That afternoon a party of officers visited the fortress, saw what little effect the various bombardments had had, and also saw the huge craters the dynamite charges from the *Vesuvius* had made where they landed in front of the walls.

It was not until the second day after the surrender that some three others, including myself, were able to visit the Morro and talk to our army officer in command—a lieutenant. In reply to our inquiry he stated that one of the war correspondents on the newspaper boat that had entered the harbor after the surrender, had brought with him one of their flags, and had asked the lieutenant to "Please hoist the American flag over the Morro. We have been waiting weeks to see it, and if you haven't one handy, we will donate this one."

The officer was ready to oblige, and so an American yacht ensign floated over the old fortress until sunset.

We asked to see the flag and it was passed round, reaching me last. When I asked what the lieutenant was going to do with it, he replied that he had no use for it, and that "you can have it if you wish." So it has been in my possession ever since.*

* A few years later in one of the service papers, an army officer stated that he had the first flag hoisted over the Morro. His was probably the flag hoisted the second day. Some time later I

That evening as we were talking over the events of the day around the ward room table, I mentioned the above, also that I had had an idea that the Spanish flag which the *Oregon* had shot down might still be on the staff hanging over the cliff, but I found that only the remains of the staff were there. Thereupon the chaplain, A. L. Royce, spoke up and said that he had been in the party on the first day and had gone to the edge of the cliff and, after a perilous climb down and back, the flag was his and was then in his room.

Cruiser Types

(See page 278, March, 1927, PROCEEDINGS)

LIEUTENANT COMMANDER J. W. REEVES, JR., U. S. NAVY.—In his article on "Cruiser Types" in the March number of the PROCEEDINGS, Lieutenant Percival recommends that the cruiser building program for the U. S. Navy be divided among three different types. These are the "Destroyer Scout," similar to the destroyer leader of foreign navies; the "Armored Cruiser," similar to the type of the same name formerly built by our Navy; and the "Scout Cruiser," similar to the *Richmond*, but larger and more heavily armed. The writer believes that our Navy's need of destroyer leaders is not nearly so urgent as its need for cruisers, and that the former cannot satisfactorily perform the duties of the latter. He believes the armored cruiser to be an unsound type, and one that cannot be built with the characteristics proposed on the displacement allowed. There follows a statement of the characteristics and the proposed uses of the destroyer scout and armored cruiser as suggested by Lieutenant Percival. Consideration is given to the practical possibility of attaining the characteristics desired, and to the value of the types, if attainable, in performing the fundamental functions of cruisers.

"Destroyer Scouts" are described as being of about 3,000 tons displacement; thirty-two knots speed; no armor; four six-inch guns in two twin gun houses; twelve 37-MM anti-aircraft guns; thirty torpedoes; including two different types; one plane; four depth charges in chutes; one Y-gun with a load and one complete set of reloads; flag quarters; and Diesel cruising engines. Even were the vessel designed solely as a destroyer leader, some of these specifications might well give rise to adverse comment. First a designed speed of thirty-two knots is not enough for a vessel supposed to lead other vessels with a designed speed of thirty-five knots. The foreign practice of giving leaders a slight excess in speed is based on experience in maneuvers and is sound. There will be differences of opinion as to two types of torpedoes. Whatever the advantages, there are certain disadvantages inherent in multiplying types. The depth charges carried are, as Lieutenant Percival implies, not sufficient "to drop a really effective barrage." There is no valid excuse for taking up weight and space with anything that is less than adequate to perform the function for which it exists. The result of such a policy, of which we have some examples in our Navy, is a vessel that looks well on paper, but a jack of all trades and a master of none. She can do a little of everything, but can perform no one function dependably and well.

The projected scouts are intended to carry out the following duties:

(a) Scouting.
(b) Destroyer leader, torpedo attacks, counter attacks.
(c) For conversion to carry coastal motor boats or mines.
(d) Raiding on convoys or communication lines.
(e) Gunboat duty.

The U. S. Navy is so deficient in cruisers that it is forced to use destroyers in the scouting line, a duty that they have neither the radius, sea keeping qualities, nor gun power to perform properly. Undoubtedly a destroyer scout, being larger and better gunned, could do scouting duty better than a destroyer; but by the same token she

endeavored to learn the name of the lieutenant who had been in command at the Morro on those days. General E. J. McClernand, who was adjutant of the Land Forces before Santiago, referred me to General Chambers McKibbin, and the latter stated, in 1910, that the best information obtainable, was that it was Lieutenant Harry E. Smith, First Artillery, who had resigned in 1902, and shortly afterwards committed suicide while temporarily deranged.

Chaplain Royce is now dead, as are the two officers who were with me, Ensign Frank Marble, and Chief Boatswain Philip Mullen, but the latter wrote me in 1915, that he distinctly remembered the incidents as here related, and congratulated me that I had been able to retain my memento, as all of his souvenirs, although of lesser importance, had been either lost or stolen.

could not do it as well as a fast cruiser armed with eight-inch guns. The functions in scouting are to obtain information, to deny information to the enemy, and to track. The smaller vessel can be prevented by her larger and more powerful adversary from attaining her object; she cannot prevent the larger vessel from attaining hers. In other words the powers of a destroyer scout are not adequate to perform the chief duty of a cruiser—scouting.

As a destroyer leader, the type, except for deficiency in speed, is undoubtedly satisfactory; foreign service tests have demonstrated that. But what bearing has that upon the value of the type as cruisers? What matters their value as mine layers, or as carriers of coastal motor boats? What we lack is cruisers, and what we want to build is cruisers; that is ships that can best perform those functions. If this could be kept in mind to the exclusion of side shows for which the vessels could be used when there happened to be no "cruiser work" in hand, the resulting designs would be better.

Raiding operations are secondary in nature. Seldom if ever are they a vital part of offensive operations, the rôle which our Navy is traditionally presumed to occupy in war. Imagining for the sake of argument special conditions in which the raider plays an essential part, it must be apparent that lack of gun power seriously handicaps the use of this type for that purpose.

In cruiser duty vessels of the destroyer and light cruiser type have been given actual trial and have been found wanting. They are hot and uncomfortable; much space is necessarily devoted to machinery, and, for tropical service and long cruises, living conditions are far less satisfactory than on vessels designed for the purpose.

It will doubtless remain a matter of opinion whether the four destroyer scouts that might possibly be built for the cost of one large cruiser would be equivalent to it in value. Whatever one's opinion, it must be apparent that the smaller vessels, unless grouped together or supported by heavy ships, would fail in the essential mission of cruisers—scouting and screening—if opposed by large and modern enemy cruisers. If the smaller vessels can be used only in groups or when supported, they become an encumbrance, and any reason for building them as cruisers vanishes.

The second cruiser type proposed by Lieutenant Percival is the armored cruiser with the following characteristics: 10,000 tons displacement; eight-inch guns, number dependent on weight available after fulfilling other requirements; twelve three-inch guns; twelve 37-MM anti-aircraft guns; armor sufficient to keep out eight-inch shell, with a generous margin for future development; twenty-five knots speed. The proposed functions of this type are as follows:

(*a*) Fleet screening.
(*b*) Support to destroyers and scout cruisers.
(*c*) Ocean escort.
(*d*) Fleet flagship.
(*e*) Towing damaged vessels.

The armored cruiser type has been tried out in the United States and foreign navies and has been considered by the majority opinion to be unsatisfactory. It cannot oppose battleships or battle cruisers for it has neither the offensive nor defensive power necessary. It cannot perform satisfactorily the functions of a cruiser for it has not the speed necessary. There are two important duties in which the lack of high speed is no great disadvantage, while armor protection may be exceedingly valuable; viz., screening and escorting. However, while enemy forces possess battle cruisers or twenty-five knot battleships which are not contained or destroyed, these duties cannot be performed by anything less powerful than our own battleships. Generally speaking it must be admitted that speed is necessary for a proper performance of cruiser duties; and the proposed type sacrifices it for the sake of armor protection "sufficient to keep out eight-inch shells." Even if the sacrifice in speed attained its object—protection against eight-inch shells—it might still be questionable policy.

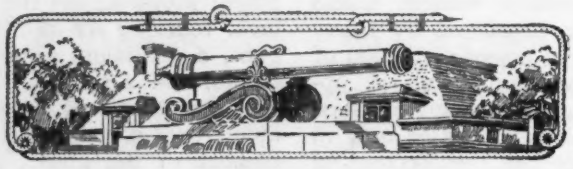
Consider the characteristics proposed for this type in conjunction with those of the old armored cruiser. The latter normally displaced about 14,000 tons; had four eight-inch, fourteen six-inch, and ten three-inch guns, a maximum armor thickness of six inches, and a speed of twenty-two knots. The armament was not equal to that of the modern scout cruiser, which has double the number of big guns. The armor was a compromise, more than necessary to keep out small shell, but not enough to keep out eight-inch and larger. The speed was three

knots below the comparatively low speed of the proposed type. And with all these deficiencies the vessel was 4,000 tons over the treaty cruiser displacement. Just what could have been done to increase materially the number of eight-inch guns; the thickness of armor; the speed, and at the same time to reduce the displacement 4,000 tons is not apparent.

Consider the characteristics of the modern scout cruiser, in which the Japanese appear to have been most successful in getting the largest measure of the desired characteristics on the allowed displacement. Their latest class, to be completed in 1927-28, displaces 10,000 tons, has nine eight-inch guns; some anti-aircraft guns and torpedo tubes; three to four inches of side armor over vitals; and 33.5 knots speed. The British, Italians, and French have laid down cruisers of 10,000 tons, eight eight-inch guns, torpedo tubes, planes, thirty-two to thirty-three knots, and three to four inches of deck armor. In other words, modern designs are providing the desired characteristics, including armament and speed, but are finding it impossible to provide more than three or four inches of armor over vitals. This provides protection against nothing larger than five-inch shell, and requires over ten per cent of the displacement. Protection against eight-inch shell would require more than double this percentage of the displacement; and this would not include covering any but vital spots, nor would it provide against plunging fire at long ranges. To obtain this additional weight for protection at the expense of machinery, as has been suggested, would reduce the speed to that of a battleship. It would result in protecting certain vital parts —except against plunging fire—but it would leave unprotected many portions where a single hit might seriously reduce the fighting value or perhaps disable the vessel entirely. It is believed to be generally conceded that complete protection against eight-inch shell on a displacement of 10,000 tons is impossible.

The third and remaining type is the scout cruiser with high speed, eight-inch guns, torpedoes, planes, and as much protection as can be included on the allowed displacement after the more essential qualities of a cruiser have been provided for. Lieutenant Percival calls this an unsound type because it can be "utterly destroyed by a single hit from one of her own class." With the exception of the battleship, this is true of every class of warship that floats—the cruiser, gunboat, destroyer, minelayer, or submarine. Even the airplane carrier can be sunk by a single bomb dropped from a plane. Judged by the standard of vulnerability alone, they are all unsound types. But shall all things be judged by vulnerability? Does not soundness of type depend rather on all around ability to perform the functions for which it was designed?

"Tin-clad suicide ship" is a catch phrase; not an appeal to reason. Reason tells us that limitation of cruisers to 7,000 tons and six inch guns would leave Great Britain with thirteen 10,000-ton cruisers, and the United States with eight—when and if the latter are built. Furthermore, it would rescue from impending oblivion the remainder of the British cruisers of 4,000 to 5,000 tons displacement and six-inch gun armament. These vessels, by the advent of 10,000-ton eight-inch gun treaty cruisers, are headed for the fate of the predreadnought battleships on the introduction of dreadnoughts. Whatever might result from limitation of cruisers to 7,000 tons and six-inch guns, nothing is more certain than that cruisers would remain "tin-clads." Let us interest ourselves rather in proposals calculated to pull our own chestnuts out of the fire, not someone else's.



Courtesy of the Boeing Airplane Company, Seattle, Washington

A Navy Seaplane for Patrol Work

Courtesy of Los Angeles Examiner and International News Reel

LOENING AMPHIBIAN BEING CATAPULTED FROM A BATTLESHIP
The power plant is a Packard 1500 Inverted Engine.

UNITED STATES
GREAT BRITAIN
FRANCE
JAPAN
ITALY
ENGLAND
AVIATION
CURRENT

PROFESSIONAL NOTES

30 APRIL TO 1 JUNE

COMPILED BY

LIEUTENANT COMMANDER W. G. GREENMAN, U. S. NAVY

AND

ASSISTANT PROFESSOR HENRY BLUESTONE, U. S. NAVAL ACADEMY

GENERAL ARRANGEMENT

UNITED STATES

The American Merchant Marine Policy..... 802

GREAT BRITAIN

Navy Estimates and the One Power Standard..... 802

FRANCE

Defense of the French Colonial Empire..... 803

JAPAN

Japan's Self Sacrifice..... 804

ITALY

Italian Shipping Develops Under High Pressure..... 805

ENGINEERING

Helium in Canada..... 807

AVIATION

Apparent Present Tendencies in Airplane Design..... 808

CURRENT ARTICLES AND BOOKS..... 813

LOENING AMPHIBIAN BEING CATAPULTED FROM A BATTLESHIP
The power plant is a Packard 1500 Inverted Engine.

UNITED STATES

The American Merchant Marine Policy

Christian Science Monitor, May 14.—The attitude of American steamship operators toward continued government operation of the merchant ships may be summarized briefly: Government management is unwise, but private operators are unable or unwilling to purchase the ships at a fair price and to guarantee their continued operation on established trade routes for a period of years. Until private capital can be interested in acquiring the present ships, or constructing new ones, the policy of the Shipping Board is clear, T. V. O'Connor, its chairman, being on record as asserting that the board intends to carry out the Merchant Marine Act, which provides for an American merchant marine, ultimately to be privately owned. But until private American capital can and will take them over, ships are to be operated for the protection of commerce and national security.

This was the substance of a message sent to the Pacific American Steamship Association in response to a query which that organization addressed to Mr. O'Connor asking the Board's position, as a result of the action taken by the United States Chamber of Commerce in passing a resolution favoring a privately owned merchant marine. Undoubtedly, among the members of the chamber are many ship operators, and it is only through them that a policy of private operation of the fleet may be looked to. Their plans thus far have given little indication that they contemplate purchasing any of the ships.

Meanwhile, the Shipping Board is undertaking to see that the flag of the United States is kept on the seas. Passenger and freight routes have been established, managed, in general, by operators for the board on a commission basis, and the losses of the fleet have gradually decreased, according to apparently official reports.

Steps are being taken which may result in the construction of two large liners in the Atlantic to run with the *Leviathan,* and even though this step is not effectuated, the Merchant Fleet Corporation (as the "Emergency" Fleet is henceforth to be known) intends to renovate two of the larger vessels now laid up. If present plans go through, the renovation will be equivalent to a complete rebuilding of the ships. To be operated in the United States Lines, these ships promise to bring to that government line badly needed additional passenger-carrying space, for despite the assertion that "dry" ships do not appeal to ocean travelers, the *Leviathan* carried the largest number of passengers last year, and other ships of the line are always well patronized.

Regardless of the individual's belief in the advantages or demerits of government operation of a merchant fleet, the fact that private operators have not undertaken to keep the flag of the United States on the seas makes it the more satisfying to realize that the Shipping Board intends to maintain a fleet until such time as the vessels may be turned over to other operators.

GREAT BRITAIN

Naval Estimates and the One Power Standard

Engineering, May 13.—(EDITOR'S NOTE.—The article to which the letter refers appears on page 692 of the June, 1927, PROCEEDINGS OF THE U. S. NAVAL INSTITUTE.)

TO THE EDITOR OF ENGINEERING.

SIR: I have been much interested in reading your leading article on pages 359 and 360 of your March 25 issue. Unfortunately, I am afraid I cannot agree with some of the conclusions you have drawn from statements made. Near the top of page 360 you say, "The United States at present possesses thirty-two cruisers." This statement is correct in so far as it goes, but below in the middle of that paragraph you state, "A question of such gravity must obviously be examined with the greatest possible impartiality."

Permit me to inquire whether the impartiality with which this case was examined in your columns took account of the fact that three of the American cruisers listed were launched and in service before the Spanish-American War of nearly thirty years ago; that one of them, then six years old from date of launching, was Admiral Dewey's flagship at the Battle of Manila Bay, and that another of them, then seven years old, was Admiral Sampson's flagship before Santiago. I wonder if that impartiality at the same time took account of the fact that only ten of these cruisers are less than

twenty years old from the year of launching and that the twenty-two old ships are mostly of such low military value, measured by present standards, as to be almost wholly obsolescent. As a matter of fact, ten of the whole group are of less than 4,000 tons displacement and seven of this number possess the triple disability of diminutive size, low speed (under twenty knots) and ancient vintage (all twenty-four years old or more).

How any one investigating this problem with the greatest possible impartiality could use mere numbers and thus equate these lame ducks to the fine high-speed cruisers in the British fleet passes my limited ability to understand. As I understand it, none of the forty-seven British cruisers considered by you was launched earlier than 1912, and all have made twenty-eight knots or better. Only ten of the Americans can approach that speed. That there may be no misunderstanding as to the list of American cruisers, I am appending that list in groups by classes of ships:

	Tons	Launched	Speed Knots
10 Omaha Class	7,500	1921–24	34
3 Chester Class	3,750	1907	25
3 Seattle Class	14,500	1905–06	22
2 St. Louis Class	9,700	1904–05	22
5 Pittsburgh Class ...	13,680	1903–04	22
5 Denver Class	3,200	1901–03	16
2 New Orleans Class..	3,430	1896–99	20
1 Olympia Class	5,865	1892	21
1 Rochester Class	8,150	1891	21
32			

I should much appreciate your opinion of this matter in the light of some of the above facts.

Yours very truly,

SIDNEY G. KOON, M.M.E.
Associate Editor, "The Iron Age"; during the late War, Inspector of Naval Construction, U.S.N.
The Iron Age,
239 West Thirty-ninth Street,
NEW YORK.

[We must refer Mr. Koon to the text of the article. Its whole purpose was to show that numerical and strategical naval equality were absolutely different things, and that a country's naval power should be related to the strategical duties that its fleet performs. We equated the thirty-two United States cruisers with nothing, but stated that after deducting fifteen cruisers for reconnaissance work, the United States would have seventeen left over "for concentration upon any trade route that the American staff might select." If Mr. Koon desires to show that the statement is misleading, he would be well advised to criticise the article as a whole instead of concentrating upon two sentences from it.—ED. E.]

FRANCE

Defense of the French Colonial Empire

Le Yacht, May 7.—This is a vast subject, difficult to consider from the maritime viewpoint alone. It is evident, as shown by experience of the war, that the preservation of a colony of a colonial empire is the happy result of parallel efforts exerted in the domains of politics, marine, diplomacy, and army.

I do not think I shall merit the reproach of professional exaggeration if I say that the defense of the colonies is, above all, a maritime question. By this I do not mean the military fleet alone, but also the merchant fleet; for although the two are different in the means employed, it must not be forgotten that the merchant fleet operates under the protection of the Navy and that the Navy can live only through the normal operation of the merchant fleet.

The French colonial empire is scattered all over the world. That constitutes an element of strength but also one of weakness: strength, from the economic point of view on account of the variety of products yielded and produced and the relations established by French commerce through the colonists; weakness, from the military point of view, on account of the difficulty of defending them.

England, whose colonial empire is more extensive and more scattered than ours, has always maintained the following principle: to have the strongest navy in the world, in order to assure in an absolute manner the security and prosperity of the colonies. Not content with having acquired the first point, England has created autonomy of the Dominions—Australia has her navy and her army, as do Canada, the Indies, the Cape.

In this fashion, a system of great autonomous centers was established, constituting basis of resistance and security for the more feeble elements of the British empire.

But every nation cannot have the strong-

est navy in the world. What method is to be employed to assure the preservation and security of our trans-oceanic possessions? Let us cast a glance around us. There is, in Europe, a country with an area of 34,000 square kilometers and seven million inhabitants, whose Far Eastern colonies have an area of 2,000,000 square kilometers and a population of 50,000,000.

This small country, Holland, has given the most magnificent example of what can be done by a nation with its will bent of colonial problems. The economic results did not intoxicate the practical minds of the Dutch, who were bent, before all, on paying the premium of security for their capital invested in the Dutch East Indies. This premium for security is the aviation fleet, the submarine fleet in particular, whose defensive power is sufficiently established to discourage foreign covetousness.

The Dutch, knowing that their trans-oceanic colonies were secure, did not hesitate to send heavy amounts for the exploitation of the economic resources of which they are sure to have possession. Sixty billion francs came to fecilitate the work undertaken in Java, Borneo, Madura, Sumatra, and Celebes.

During the same time, French capital was flowing to Russia. Since the war, after so many failures, such capital is looking for security.

Indo-China and Madagascar have attracted many purses, but consult maritime year books: what forces have we to meet mere incursions of pirates? Is our Far East sample fleet an adequate bulwark to discourage covetousness, the satisfaction of which is delayed only by traditional rivalry in the Pacific?

Indo-China plays in Asia the part that Turkey played in Europe before the war, except that Indo-China is richer and therefore more desirable. If tomorrow a strong fleet were to declare a blockade of the coast of Indo-China, who could prevent or even hinder such measure? This idea is enough to make some folks smile, because it seems so simple, so excessive. Had anyone, in May, 1914, predicted Charleroi, he would have been considered a fanatic; whatever may be said, Indo-China is not protected from the naval point of view; and yet we have a Navy.

Many will answer that, in case of alarm, it would be enough to send ships to Indo-China. Evidently so. But it would take them thirty days to reach destination; they would perhaps find their base destroyed or captured; and, even assuming that they would find these bases intact, the yards would not be adequate to make the necessary repairs on new ships whose technical complexity requires a specialized personnel and special tools.

Let us, therefore, use the Dutch method. This procedure offers sufficient guaranty to capital, which is only waiting for a chance to fructify the lands, whose future is now burdened with uncertainty.

It is indispensable that tomorrow should see the creation of fleets for Indo-China, Madagascar, the West Indies and the Pacific.

The forces cruising in the waters of the above mentioned colonies are of slight military value. We must begin with Indo-China by sending fighting groups consisting of submarines and hydroplanes; it will be well to add some light surface units, but that is a matter of detail to be closely studied. What is important is to establish, as early as practicable, the fleet of Indo-China, which will by means duplicate the work of the naval division of the Far East, as shown by the events in China, at Shanghai.

After Indo-China, we shall have to attend to Madagascar, which was formerly the favorite of *rue Royale*. At Diego-Juarez there existed a complete naval base, all the ships of which were abandoned to the military administration of the colony. Why not resume the old traditions? You will say that all that requires money, and men and ships. Exactly so; but still, that combination of defense by submarines and aviation is by far the most economic. And even were it expensive it would be justified in view of the vast amounts to be protected.

JAPAN

Japan's Self-Sacrifice

Japan Advertiser, April 12.—Our editorial on April 6, "What our officers in the military profession are doing," aroused echoes. Contributions of varied descriptions are being made, some are of a reproachful tone, others are resentful, while

many strongly protest against the argument. We have, however, ascertained that the meaning of our editorial view is misunderstood. It is not our intention to remind the general public of how new life was given to modern Japan and of whose merit it was, but it is our earnest and sincere hope that the public will recollect that the greatness of New Japan is indebted to the self-sacrifice of military officers and also to the patriotic ardor of her subjects. This effort will not be futile at a time when our lives and property in China are massacred, insulted and robbed.

We did not say that our officers in the military professions have become effeminate and imbecile. However patriotic and ready to give up their lives for the sake of the State, the courage of men in the military profession will be of no avail if the government is heartless. Weak foreign policy will deprive the military officers of an opportunity to establish their preparedness for emergencies. In this sense, we accuse our Foreign Minister of irresolute decision and venture to urge the government to take determined steps. His weakness is resented not only by the public opinion of this country but also by the British Government, which is said to have gone the length of representing Japan as looking for an opportunity to grasp material gain out of international chaos.

We may be allowed to state without injustice that cunning policies of the Western nations made Japan extremely cautious in respect to China, so it is impertinent of them, when they are worried by the Chinese, to press this nation to draw the chestnuts out of the fire. We would like to point out to them that the foreign policy of Japan has entered from meditation into slumber. The bell of warning will not rouse them to consciousness, for sleep in warm and cozy spring is especially sweet. Public opinion in this country is not energetic because there are but few frantic patriots. We regret to state but it is true that the patriotism of this nation is paralyzed by the tempting influence of gold.

The foreign policy of Japan was condemned as dual, for war authorities of the past were unduly influential. We feel pressed by necessity to call in their help, for our representative was handled humiliatingly and insulted by Chinese mobs in Hankow. Even though Baron Shidehara is irresolute and weak, he may have already exhausted the stock of endurance.

Some harshly blame our contention, arguing that an armed policy would result in the loss of lives. Do they mean that they will assent to the dispatch of troops provided the loss of lives be avoided? They do not care for the safety of a great many lives in China. At the Privy Council yesterday the Foreign Minister is said to have manifested his decision to take resolute steps in case of insult to the honor of the nation and further loss of lives. Is Baron Shidehara of the opinion that lives, property and honor were safe from insults, disgrace and humiliation in Nanking and Hankow? No matter what this may be, we reiterate what we said in "What our officers in the military profession are doing," and conclude our arguments.

ITALY

Italian Shipping Develops Under High Pressure

Nautical Gazette, May 14.—Activities of the Italian shipowners in developing national shipping have about reached their zenith. During the past month they have received the maximum moral support of the Italian Government and the announcement of a loan of twenty million dollars raised in the United States has given a further impetus to the industry. Concurrently the reports of amalgamation of leading Italian Lines have been confirmed by Signor Ciano, Italian Minister for Communications. The extension of the free port régime to the leading Italian harbors also now has legal sanction. These harbors are Savona, Genoa, Leghorn, Naples, Messina, Palermo, Catania, Bari, Ancona, Venice, Trieste, and Fiume. This will demonstrate the desire of the government to make Italian ports centers of European trade with overseas countries; a form of help which means more to Italian shipowners than any financial assistance. Finally, and all trending in the direction of a greater merchant marine, is the conclusion of an agreement between Italy and Hungary which will have the effect of making Fiume the center for Hungarian exports to overseas markets, more especially as steps are being taken to counteract the attraction of Hamburg for Hungarian flour exports.

In order to appreciate the situation which renders it necessary for Italian shipowners to consider the question of amalgamation it must be remembered that while before the war the Italian mercantile marine played but a small part in the carriage of passengers, by 1926 their passenger trade had grown enormously. In that year Italian ships carried 56,402 passengers from Italy to America and brought from the United States to Mediterranean ports 49,263 passengers. Also a few years ago 9,000-ton steamships were considered adequate, but new ships constructed have tonnages of 24,000 and 33,000, while it is contemplated to build 45,000 ton ships. However, in the meantime, other maritime countries of Europe have planned to construct liners with a speed of twenty-eight to thirty knots. Now if the trip from the North Sea ports to the United States of America is reduced it will obviously be to the disadvantage of Italian shipping; consequently the problem Italy has to face is shortening the trip from the Mediterranean to the United States. Signor Ciano, minister for communications, has clearly outlined this in Parliament. Now the construction of three or four ships with sufficient speed to counteract competition can only become possible if Italian lines get together; otherwise, the internal competition would foil the realization of the plan. Much has been said and written about this proposed amalgamation, but nothing so far has been definitely decided. From what I can gather there will be two fusions, one between Mediterranean services and another between the trans-atlantic services; in the latter case it seems probable that a new concern will be formed under the name of Lloyd Littorio to take up the operation of three or four high speed liners to be employed on the North and South American routes.

Premier Mussolini's announcement that the time will soon come when only four or five days will be occupied in the trans-atlantic trip from Naples has been received with a good deal of skepticism. Much has been written about the mysterious propelling machinery with which these super-ships will be driven. There cannot, of course, be any doubt that Italy intends to build high speed liners; this has been confirmed in Parliament by Signor Ciano and also by Signor Broccardi, the representative of Genoa, who is in close touch with shipowners. However, this does not mean that everything written on the subject of these engines is true. Can it be left out of account, for example, that these vessels may be propelled by compound Sperry engines? Quite recently Signor Godina, one of Italy's most distinguished engineers, in the course of an address before the Circolo della Marina Mercantile at Trieste pointed out the great advantages offered by the compound Sperry engine over the ordinary type; he also compared the size and shape of the hull of the motorship *Saturnia* with the projected hulls of the high speed liners *Rex* and *Dux*.

In the circumstances it is not surprising that the government has taken up the question of extending the free port régime to include most of the Italian harbors. It has frequently happened that Italian importers purchased cotton, coffee, sugar, cocoa and so on at London, Rotterdam, Hamburg, Antwerp and other European ports, owing to the lack of markets in Italian ports. It is quite obvious that the North Sea ports did not purchase for their own requirements only, but acquired goods intended for the Mediterranean market, and it can readily be understood that under such conditions of affairs it was much easier to charter a ship from Rio de Janiero to Amsterdam or Hamburg rather than Genoa or Trieste, also charterers would have a better chance to secure return cargoes. By extending the free port régime the Italian Government has created a situation favorable for the marketing of Colonial goods in the Mediterranean. There is now no reason why American exporters to the Near East and to the Levant should not send their goods to the Italian warehouses in the free ports where they would not be subject to any customs control, and then ship them in small lots from Italian ports to Turkey, Greece and so forth when they are sold. It may readily be seen what a great influence this step has in regard to competition between Italian and North Sea ports; also what a great part the Italian-Hungarian agreement plays in the exploitation of the port of Fiume, where Hungary has been authorized not only to open her own customs and railway office, but even to register her own tonnage, which will receive the same treatment as Italian tonnage, as well as any tonnage handling Hungarian trade at Fiume. All these things show that the intention of the

Italian Government is to help the progress of Italian shipping through encouraging the development of trade rather than by granting financial help. It is known that the Italian trans-atlantic lines are not receiving a cent from the treasury even for the carriage of mails.

The Italian mercantile marine is bound to become a factor of considerable importance in the development of Mediterranean shipping. This can be seen from the fact that the Cosulich Line has decided to start calling at Marseilles with twenty-two-knot, 24,000-ton motor liners which they are to employ on the express services from Italy to South America, enabling business people from Germany, France and Switzerland to reach the River Plate in nine days.

French shipping circles are following Italian developments with the greatest attention and are considering the question of working out a shipbuilding program for the trans-atlantic trade with particular reference to South American services. Meantime, French traffics are growing larger. Tonnages for the year 1926 of the chief French ports were: Marseilles, 7,143,700; Rouen, 6,009,962; LeHavre, 4,342,000; Bordeaux, 3,602,000; Dunkirk, 2,867,900; Nantes, 1,953,000; St. Nazaire, 1,067,100.

ENGINEERING

Helium in Canada

Engineering, April 29.—From 1922 to 1926, the Mines Branch of the Dominion Department of Mines, as part of a survey of the natural gas resources of Canada, made a special study of the helium content of the gases, and a thorough examination was made of all possible sources of that element. Ten years ago helium was considered a rare substance, occupying, as regards its rarity and value, much the same position among gases that radium holds among metals.

Following the discovery by two American chemists that some natural gases contained helium in small amount, and the suggestion by a British scientist that it might be commercially possible to obtain helium from such natural gas in sufficient quantity to fill balloons and airships for war-time use, extensive investigations, commenced in 1917, were carried out in the United States, and on a smaller scale in Canada. As a result, up to the end of 1926, over twenty-five million cubic feet of helium had been obtained by the United States Government, and the cost of production reduced to a basis that will permit of commercial utilization. Helium was also extracted in small amount in the experimental plant at Calgary, operated under the direction of Professor J. C. McLennan, F.R.S., of the University of Toronto, in 1919-1920, for the British Admiralty.

Helium possesses many remarkable properties which may make it a very valuable industrial gas. It is an ideal gas for filling balloons and airships, for, although it has 10 per cent less buoyancy than hydrogen, it has the great advantage of being non-inflammable. An application of helium that promises to become of great value is its use in making up artificial atmospheres to supply to divers and workers under pressure. An investigation, still in progress, by the United States Bureau of Mines, has shown that there are great possibilities along these lines, and that such artificial oxygen-helium "airs" may permit of greater depths being attained and longer periods being spent under water by divers, and the prevention of caisson disease among tunnel and caisson workers. Suggestions for other industrial uses have been offered, but outside of the United States no commercial supplies are available.

In the survey of helium resources in Canada made by the Mines Branch it was found that the gas from three small wells at Inglewood, Ontario, contained as high a percentage of helium as that treated in the United States Government plant at Fort Worth, Texas. The Ontario Government has since taken up many of the leases in that neighborhood, and it is anticipated that the National Research Council may establish an experimental helium extraction plant, if it be proved that sufficient gas is available. A few wells in other fields in Ontario, particularly in Norfolk county, yield gas carrying .5 per cent helium. Natural gas in Alberta, where much larger quantities are available than in Ontario, was found to contain little or no helium, with the exception of that from the Bow Island and Foremost Fields. If natural gas, containing as little as .2 per cent helium, could be economically treated to extract helium, it is calculated that about five million cubic feet could be obtained in Canada annually.

The results of this investigation are described in a report "Helium in Canada," by Dr. R. T. Elworthy, recently issued by the Mines Branch, which contains a brief account of the particulars and occurrences of helium, the methods employed in the work, and some account of the methods of recovery of helium and its uses.

AVIATION

Apparent Present Tendencies in Airplane Design

V. E. Clark in *Aviation*,* May 9.—A discussion of the tendency in airplane design might deal with one or both of two phases: (*a*) the past and present, and (*b*) the future. In this paper the author, lacking the courage to venture predictions, will confine himself to a brief review of the immediate past.

It seems that a fair answer to the question, "In what direction is airplane design leading?" would be: "Scattering in all directions." At no time during the brief history of aviation have there been *successful* airplanes of so many widely differing types —aërodynamic and structural.

One reason for this encouragingly healthy state of affairs may be that more and more engineers are being developed who combine native imagination with a sound knowledge of the pertinent fundamental sciences and a sufficient amount of practical experience (and horse sense) to justify risking the hazards of pioneering, instead of cautiously copying a traditional scheme that has "worked" but which may have become conventional merely because it happened to have been the luckiest result of several early cut-and-try endeavors. One says "encouragingly healthy" with the firm conviction that it would be most unfortunate for us to attempt to standardize at this time, on the assumption that the possibilities of the science have been sufficiently thoroughly investigated and developed to warrant standardization. To be trite, the longer one observes aviation the more one must realize what a tremendous amount is to be learned.

The diversity of development between nations is much greater than that between constructors of any one nation. While there is no defined "school" of design adopted within any one nation, there is consistently more similarity intranational than international. One reason for this is the influence of governmental policies as affected by peculiar contemplated military problems and by the availability, among national resources, of special basic materials. Great Britain, for example, must build airplanes which will be durable in all sorts of climates, hot and cold, dry and wet, and which may be maintained in service thousands of miles across the water from their home factories. Other nations lack certain indigenous basic materials. The United States, in this particular, is very fortunate. We have iron, chromium, molybdenum, nickel, silicon, manganese, vanadium, aluminum, copper, magnesium, cadmium, spruce, birch, long-fiber cotton, nitrates, and fuel and lubricating oils. In fact, nature has endowed our country with every element necessary for the fabrication and operation of aircraft. For the few elements we lack, we have acceptable substitutes.

Great Britain.—Of the great powers, England is probably the most conservative in aërodynamic design and in the use of materials and manufacturing processes. By far the great majority of modern successful British airplanes are of the type which has flown well for the longest time: the tractor biplane with wings of thin section externally braced, usually with a two-bay cellule and usually of equal spread and chord. Most of the construction is of wood, with fittings of sheet steel. Captain De Haviland, whose *DH-4* we know so well in this country, has designed a great number of useful machines, in the general scheme of all adhering to the type of aërodynamic design and of construction which he adopted many years ago. His fuselages are of wooden sticks taking compression and forming the framework for an outside covering of plywood which completes the structure by tying the sticks together and taking diagonal tension loads.

In England, welding in vital structures is discouraged. Very little duralumin (we shall use this term for aluminum-copper alloys for convenience at the cost of accuracy) is used, notwithstanding the fact that one of the foremost airplane manufacturers, the Vickers Company, fabricate this material commercially in various forms. The Boulton & Paul Company builds its structures

* Paper presented at the National Meeting of the A.S.M.E. Aëronautic Division, Buffalo, New York, April 25-26, 1927.

of very thin high-grade steel sheet, with sections so formed and riveted together as to resist local buckling failures.

The development of La Cierva's "autogiro," invented in Spain, is evidently being encouraged to some extent. In this machine vertical lift is obtained, not by flexed wings, but by four monoplanes above the fuselage rotating propeller-wise about a vertical axis. Rotation is started by external power before take-off and continues due to the nature of precision of air forces, during revolution, on this peculiar airscrew, as long as there is relative air velocity. The machine is propelled through the air by a conventional tractor propeller-motor unit mounted in a standard fuselage with tail surfaces. Due to relatively high "tip" velocities of wing blades, the airplane can take off and land at comparatively slow true air speed, with resulting short run. The gyroscopic effort of the mass of the rotating wings, with large diameter, tends to stabilize the machine in the air. It is very doubtful, however, whether this machine will compare favorably with an airplane with fixed wings, when it comes to carrying a given load a given distance with given power *in a given time.*

Handley Page has been developing, for a number of years, "slots" for wings. The auxiliary entering edge vanes and trailing edges of wings to form these slots may be opened and closed during flight. The purpose is to delay discontinuity of air flow above an airfoil, or "burbling," with resultant loss of lift, until a very high angle of attack has been reached. The result is that a given airplane, with given wing area, can land at a given speed with about sixty per cent more gross weight (perhaps over a hundred per cent more pay load) than it could without the slots.

France.—France has built a tremendous number of military airplanes. Tourists in Europe may hold that the experienced constructors of France have built so many military machines that they can never learn to build *comfortable* passenger transports.

French airplane ideas are well diversified. Many of their modern machines are "sesquiplans"—with a wing and a half—the upper plane having a much greater spread, and usually greater chord, than the lower. The famous *Breguet XIX* which has flown 3,400 miles cross-country without landing exemplifies this type. There are also many monoplanes braced externally by a single pair of tension-compression struts extending diagonally out from the bottom of the fuselage. This very attractive type was developed by Loening in the United States and by the Morane-Saulnier Company in France. The Wibault is a very interesting French machine of this type—an all-metal monoplane of rather simple construction covered by thin sheet "alferium." In his latest machines Wibault uses no wires, all loads being taken by compression-tension members.

French engineers seem to have no fear of the "rack and ruin" from landings. This is evidenced in three ways: (1) The very small travel shock absorbers; (2) the tendency to attach important structural members for wing bracing to the undercarriage; and (3) the general lightness, even flimsiness, of the structure throughout the airplane—ill-suited, one would think, to withstand the racking incident to hundreds of landings—average landings as we know them in this country. It may be that all French pilots are artists at landing, or that they are expected to land only on fine fields, or it may be that French engineers have learned how to make structures very flexible and shock absorbing and yet strong and durable. Or perhaps the military are willing to sacrifice an airplane every so often in order to save weight and the last word in performance. At any rate the French school in this respect is far different from ours.

The Société d'Emboutissage et de Constructions Mécaniques has installed a large equipment of special machinery toward reduction to real production methods. Their construction is largely of stamped sheet metal in shapes and combinations which look expensive but may not be.

Germany.—There is no more interesting development than that in Germany. Restrictions imposed by the Allies after the armistice made it illegal for Germany to build airplanes which even remotely resembled military machines. Certain other restrictions at that time put a premium upon getting the most out of a limited amount of horsepower. These rules have forced German engineers into lines of endeavor which may result, within the near future, in Germany's leading the world in commercial aviation. Their airplanes are, from the time of first conception, designed with the

sole thought of commercial utility. Except in a few instances, the general design schemes of other so-called commercial airplanes are modifications of those of previous military machines. Furthermore, German engineers and scientists have been forced into a deal of fundamental research, at which there are none more thorough and systematic, in aërodynamics and in the development and use of suitable materials.

The most successful engineers today, Dornier, Rohrbach, Junkers, and others, apparently agree on at least two important principles, viz., (*a*) the monoplane, and (*b*) the stressed skin or covering of thin duralumin sheet.

Junkers has always used his skin, on wings, fuselage, and other surfaces in the corrugated form, which has a distinct advantage in resisting "drum head" vibration and resulting fatigue failure at rivet-attachment points. Corrugated sheet has, of course, the added advantage of being capable of taking compression loads in and bending loads normal to, the direction of the corrugations. It has, however, no rigidity in the other direction, is hard to work in such manner as to give a neat appearance where it is necessary to change to a "flat" along edges, and there is some question as to the efficiency of rivets as they must be pitched in a curved surface. Junkers has preferred the straight cantilever wing, strongly tapered both in plan and depth, usually located at the bottom of the fuselage with considerable dihedral. In this cantilever he has not used prime beams but, rather, has replaced chord members by a number of round seamless duralumin tubes, distributed throughout the entire wing section and triangulated together by riveted duralumin strips, beaded to give rigidity in compression except at the ends, which are flat and riveted to the tubes. These strips lie in every direction necessary to complete, in conjunction with the skin, the trusses for lift, drag, and torsion.

The structure is very rigid but, to all appearances, very costly in man-hours, because of the tremendous number of rivets which must be headed from the inside of tubes and at other inaccessible or, at best, uncomfortable places.

Notwithstanding the fact that a closed tube is the most economical (from the strength-weight standpoint), reliable, and determinate section with which to take compression loads, and avoids *edges*, which, in duralumin, give us lots of worry, it is a bad thing to which to rivet, as the rivet heads inside cannot be inspected.

Flying Boats.—Dornier, who builds flying boats and land-type airplanes, convertible as seaplanes, locates his wing above the fuselage, usually with some gap between. His wing is not tapered either in plan or depth. It is braced externally by long struts attached to the bottom of the fuselage, one leading to each of the two main wing beams. These reduce by half the length of the cantilever. For normal flying loads, these struts are in tension. Being long columns, they are weaker in compression to take reverse loads, but the reverse loads are of far less magnitude than the normal loads. His two wing beams and other important highly stressed parts are of formed heat-treated alloy steel. He uses flat thin-sheet duralumin skin to take stresses from drag and other loads. The skin is stiffened by channels or flanged U-sections, laid at right angles to each other. The channels lying in direction of flight are riveted outside the skin, top and bottom, and take the place of the compression cap strips in our old-fashioned ribs. Thwartship channels are riveted inside the skin. His airplanes are covered all over by duralumin sheets, except the ailerons, where he uses fabric to reduce weight and static hinge moment, thereby reducing the danger of wing flutter.

On his flying boats lateral stability on the water is obtained (?) by streamline sponsons built out from the main hull. On the Super-Wal two engines are mounted in tandem above the center of the wing.

Both the Super-Wal and Rohrbach's latest flying boat have succeeded in getting off the water with a useful load greater than the weight of the empty machine with power plant.

Rohrbach, who specializes in rather large flying boats, has evidently given a great deal of attention to the reduction of production costs. This has lead him toward an adaptation of shipbuilding practice.

His monoplane wing is cantilever except that, by means of two tightly strung wires leading down and inboard from a station about half-way out, he imposes an initial bending moment and stresses on the inboard part of his wing girders of the opposite

nature to those imposed in normal flight, thereby reducing the latter. In spite of the fact that the wing is well above the hull, he has chosen to use a very strong dihedral. At first glance one would say that the resulting lateral stability would be so great that maneuverability would be poor. He has stated, however, surprisingly enough, that this dihedral is necessary to *reduce instability*, thereby, of course, improving maneuverability. Until very recently his wing has been without taper in plan, but now, we hear, he uses some taper. His wing loading is extraordinarily high.

His study toward reducing production costs has been along the lines of dividing the wings and other major parts into a great number of separate units. He finishes fabrication of each of these, which permits a great number of men to work without getting in each other's way, and makes the final assembly very simple. Comparatively unskilled labor may be used.

For example, instead of building two wing beams, attaching a lot of ribs, and then applying a covering on this skeleton, he does something like this: The wing is divided into three parts by planes perpendicular to the chord and extending athwartship. The prime structural part is a sort of box girder and includes what we ordinarily call our two wing spars, together with drag bracing, and everything that is located between the two spars. The rounded entering-edge and the trailing-edge sections are built up separately and bolted in place in final assembly. These are readily removable for purposes of inspection and repair. All parts of the wing are of flat sheet metal, with angle sections for mutual attachment. The prime structural box girder is like a long thin caisson or tank, made up, following his principle, of a number of sections, covered top and bottom with comparatively thick imperforate duralumin sheet which serves to resist drag loads. At front and rear are his "wing spars," each made up of a web member and chord members. The web member is of heavy sheet with lightening holes which provide access to the inside of the "tank" for riveting and inspection. The chord members of the individual spars are double angles to which the skin, top or bottom, is attached. Between the four walls of the "tank," extending fore and aft, are a number of fore-and-aft "baffle-plate bulkheads" each of which takes the place of the web of the central portion of an old-fashioned rib. These also are of flat sheet with lightening holes. All these parts are built in sectional units and then the entire box girder riveted together by angle and channel pieces.

Holland.—The Fokker Company has adhered to the practices which it originated and which it has found successful through many years. The wings are cantilevers, tapered in plan form and depth from root to tip. The cantilever principle is used in biplanes as well as monoplanes. The wings are entirely of wood, the two main spars being a box section with laminated-spruce chord members and double plywood side webs, with vertical spruce members placed vertically within the box at proper intervals, and all glued, screwed, and tacked together. The ribs and covering are also of plywood, the covering taking all drag loads and eliminating the necessity for internal drag trussing. The structure of fuselages is entirely of welded seamless steel tube, the forward portion usually in the form of a modified Warren truss and the rear portion a Pratt truss, with diagonal wires as tension members. Fokker machines have always been noted for their ease of control and stability.

United States.—Briefly, in our country we build military biplanes, usually externally braced, sesquiplanes in our single-seater pursuits, and many monoplanes for commercial uses. Our fuselage structures are tubular, usually welded seamless steel, but sometimes duralumin. Our wing spars are usually of spruce, and our covering of doped cotton.

The particular phase of aviation in which we, without argument, stand at the head of the world is our Air Mail Service, which operates at night over bad country and in all sorts of thick weather. Our Air Mail Service has been, in this work, remarkably successful, largely due to the pilots and to the efficiency of ground maintenance service. However, one cannot help believing that, even with the installation of light beacons, emergency landing fields, etc., our air-mail pilots, in their efforts to keep up their fine record for reliability, are still operating under conditions which are prohibitively hazardous. A lot must be done yet toward protecting them. It has been suggested that, for night flying in thick weather across bad

country, a string of "Neon" tube lights, spaced at intervals of about 300 yards along the entire course, might go far toward solving the problem, but one wonders, when contemplating the cost of light beacons, landing fields, wrecked airplanes, radio installations, meteorological services, etc., whether there may not be some other way more reliable, less costly, and *less hazardous to human life* than our present transcontinental Air Mail Service, which is getting more and more complicated as we learn more about it.

The airplane has the peculiar great inherent advantage of being able to travel swiftly at any time in a straight line from any one place to any other. But when we have a set route such as the New York-Chicago-San Francisco line, perhaps some such means as a streamline container, with no wings, riding on an overhead cable, with or without motorman, propelled by electric motor or by airplane propeller-motor unit, might be better, all things considered.

Power Plant.—There has been, since the war, great development of, and an encouraging degree of confidence in, air-cooled engines. The most popular of these are of the fixed radial arrangement, usually nine-cylinder, one piston having a master connecting rod, with the other eight rods connected thereto, all to one crankpin. The Bristol "Jupiter," developed in England and built in large numbers, under license, in France, and the Pratt and Whitney "Wasp" in the United States, have proved that 450 h.p. is practical in a unit. For this horsepower the radial air-cooled engine appears to be the lightest type, when means of cooling are included. How much more power it is good to take through one crankpin must be proved.

The inverted "V" and "in-line" arrangements, which have certain advantages, have proved practical.

The Napier "Lion" in England and the Hispano-Suiza "Broad-Arrow" in France are fine examples of "close-coupled" water-cooled engines. Each has twelve cylinders, arranged in three banks of four. Italy, with her "Schneider Trophy" Fiat has shown that it is possible to get 900 h.p. for 900 pounds, exclusive of cooling system.

All these engines are essentially for military use, however. Cost of construction, operation, and maintenance, which must be paramount for commercial uses, have been neglected.

Division of Power Plant.—There are those who argue that in using more than one engine we are only admitting weakness in power-plant reliability or in lack of landing fields. This is true, and it may be that the day is almost here when confidence in our power plant (engine proper and ignition, lubrication, fuel supply, and cooling systems) and in having a landing field always fairly handy, will have grown to the point where we shall willingly put all our eggs in one basket. The compromises in the multi-engine arrangements are many. Parasite air resistance increases badly, engine controls and fuel-supply systems become complicated, and often we must have several rudders in order that at least one may always be in the slip stream of the propeller that's turning. There is, of course (except in the case where it is necessary to provide proper fields of vision for a bomber), no excuse for division of power plant unless the airplane can fly with one engine out, and it is very confusing and discouraging to try to calculate a proper business-like airplane that can really fly, with full load, with one engine out. What we are after, in commercial aviation, is to carry the greatest number of pounds a given distance with the minimum of horsepower. When we reduce the load carried by an amount such that the airplane can really fly with half, or a third, of the power gone (more than that, really, because of reduced propeller efficiency with engines full out at reduced air speed), we are not carrying enough load per horsepower installed to be operating economically.

Summary.—As proof that the science is yet fluid, the author cites the following:

England has no welded structures; we use little else in our fuselages.

Fokker developed the welded steel-tube fuselage structure in Germany and still uses it. We in the United States followed him, but Germany did not, nor has any other nation.

France has wooden fuselages and wings of metal structure; we have metal fuselage structures and wooden wing structures.

England uses little duralumin, Germany little else, France some, we less.

England is for biplanes, Germany for monoplanes.

England's biplanes have thin wings with, usually, two-bay cellules. Our biplanes are usually single-bay, with moderately thick wing sections.

Several types of monoplanes are in use: (*a*) the pure cantilever, tapered in plan and in depth (Fokker); (*b*) the cantilever with Rohrbach's wires under initial tension; (*c*) the semi-cantilever, with constant chord and depth, braced underneath by diagonal tension—compression struts (Dornier); (*d*) the semi-cantilever, with diagonal struts, with taper in depth and diagonal or chord from root to tip. There has been a leaning toward type (*e*) in France, Germany, and, lately, in the United States.

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Man is War, by John Carter. An answer to *Why War.*

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The Empire at War, by Sir Charles Lucas, ed. A history of the British Empire during the World War. 5 vols.

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The World Crisis, 1916-18, by W. S. Churchill. A continuation of the author's history of the Great War. 3 vols.

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FROM 30 APRIL TO 1 JUNE

PREPARED BY PROFESSOR ALLAN WESTCOTT, U. S. NAVAL ACADEMY

UNITED STATES

NICARAGUAN SETTLEMENT.—Following conferences early in May with both Conservative and Liberal leaders, Mr. Henry L. Stimson, as special representative of the United States in Nicaragua, was able to announce at least a de facto, if not a formal, cessation of hostilities. Mr. Stimson's plan as subsequently carried out, included the following points:

1. Complete disarmament of both sides.
2. An immediate general peace to permit planting for the new crop in June.
3. A general amnesty to all persons in rebellion or exile.
4. The return of all occupied or confiscated property to its owners.
5. Participation in the Diaz Cabinet by Liberals.
6. Organization of a Nicaraguan constabulary on a non-partisan basis, commanded by American officers.
7. American supervision of the 1928 election.
8. The continuance temporarily in the country of a sufficient force of American marines to guarantee order pending the organization of the constabulary.

In giving orders to his forces to surrender their arms, General Moncada, the Liberal military leader, declared that he did so only under compulsion, "since it appears certain that the United States is preparing to take the field against us if fighting continues." President Diaz on May 5 issued an amnesty proclamation, and named Liberals to important political offices. Upon a proclamation issued by Admiral Latimer, both sides began the surrender of arms to the American forces, and up to May 27, there had been turned in 11,600 rifles and over 300 machine guns, of which 3,000 rifles and 26 machine guns were surrendered by the rebels. Lieutenant Colonel Richard Rhea, U.S.M.C., was appointed director of the native constabulary, numbering 1,000 men and officered by thirty-five marines. Dr. Juan B. Sacasa, the Liberal political chief, determined to stand aloof from any agreement recognizing Diaz as president until 1928, and with his staff left Puerta Cabezas on May 21 for Guatemala.

Upon his return to New York, Mr. Stimson declared that the fighting in Nicaragua, though on a small scale, had been carried on with great barbarity and severe losses, and that the country was drifting into a state of anarchy. He emphasized the duty of the United States to guarantee a free and fair election next year. In a letter to Secretary Wilbur he praised highly the work of Admiral Latimer, General Feland of the Marine Corps, and other officers. Of Admiral Latimer he said that "his steady poise and sound judgment, his knowledge of law, as well as his experience in international matters, rendered his assistance invaluable."

AMERICAN LEADERSHIP IN THE PACIFIC.—A new book on the United States, *Les Etats-Unis d' Aujour d'hui,* by the French writer André Siegfried, is pronounced by the London *Times* "probably the best book on America since Bryce wrote his *American Commonwealth.*" Of special interest are the chapters on American foreign relations. In the one entitled, "The United States, the Dominions, and the Pacific," M. Siegfried discerns a "disquieting element" in the growing community of interests between the British Dominions and the United States,

due to their anxiety for the defense of Western civilization against the inroads of the Far East. "We are contemplating," he declares, "the rise of a new constellation, dominated not by politics but by racial, economic, and social considerations." America, in his opinion, has not sought after the rôle of leader and protector which Great Britain has held for so long, but she cannot escape it and has even begun to fill it.

THE WAR DEBTS AGAIN.—On May 5, the American State Department received an unexpected note from the British government taking exception to certain statements in Secretary of the Treasury Mellon's letter of March 17 to President Hibben of Princeton on the war debt agreements. Particular objection was made to the assertion that "our principal debtors are already receiving from Germany more than enough to pay their debts to the United States." Secretary Mellon in a subsequent statement admitted that the words "except Great Britain" had been omitted from the sentence quoted above, through an error of the stenographer. He insisted, however, that his main contention was that payments would not constitute a tremendous burden, and that this was supported by the admission in the British note that in 1928 British receipts from Germany and other debtors would equal her American payments. Aside from Secretary Mellon's statement and a brief acknowledgment, the United States government made no reply to the British contentions, preferring not to continue the discussion.

INTERNATIONAL CONFERENCES

NAVAL CONFERENCE ON JUNE 20.—It was formally announced by the State Department at Washington in the latter part of May that the "Three Power Naval Conference" at Geneva would open on June 20. Mr. Hugh Gibson, head of the American delegation, returned to Washington on May 25 for consultations and instructions. In a series of preliminary conferences with Rear Admiral Hilary P. Jones, chief naval adviser, Rear Admiral F. P. Schofield, and other members of the delegation, questions of general policy were decided and definite proposals were formulated.

The chief British delegates named for the Geneva conference were William C. Bridgeman, First Lord of the Admiralty, and Lord Robert Cecil; those of Japan were Admiral Saito, former Minister of Marine, and Baron Ishii, Ambassador at Paris. It was suggested that the American delegation should be strengthened by the addition of men of similar political standing, such as Secretary Kellogg, Hoover, Hughes, or John W. Davis, but no changes were actually made.

Italy, in reply to a second invitation to the conference, indicated that she might be represented by an observer, and reserved the right to send one or more naval experts to follow the discussion. In a despatch to the New York *Times* on May 11, the following account was given of the probable proposals of Great Britain:

> As for the battleships, the British may be expected to propose a reduction in maximum tonnage from the 35,000 tons fixed in the Washington naval treaty to 25,000 or even 20,000 tons, and to open a way for discussion of the feasibility of eventually abolishing battleships.
>
> As for cruisers, it would be no surprise if England suggested lowering the 10,000-ton limit to 6,000 or 7,000 tons, with provision for parity between the United States and Great Britain and an extension of the capital ship ratio to govern the cruiser strength of Japan, unless she suggests a 5-5-2 ratio for cruiser strength.
>
> On submarines Great Britain will in all likelihood move for a maximum tonnage of undersea boats to be fixed at 1,000 tons, with an ultimate cruising radius of 1,500 or 2,000 miles.
>
> With respect to the Washington naval treaty, the British may well propose that it be extended forthwith, with whatever amendments may be accepted, for a period of ten years beyond 1932, when it is now slated to expire.
>
> On the face of it, this program may appear an important step towards the limitation of naval expenditures and that policy of economy which is put forward by apostles of the limitation of armaments. But because she is the greatest sea power, it stands to reason that Great Britain's proposals merit close examination by those nations which would be affected directly by their adoption.
>
> Let it not be forgotten that Great Britain would be quite well satisfied to abolish all warships of whatever kind. Were that done, one cannon on the bow of every merchant ship would consecrate to the Union Jack the mastery of the seas, just as well as possession of the old "two power" fleet did. A comprehension of that will enable the reader to understand what the British are driving at.
>
> The general British suggestion is to limit the size of fighting craft, to limit battleships, to limit cruisers, and to limit undersea boats. That makes cheaper boats, and lightens the burden on the taxpayers. Does it not? It does, but that is not all it does.
>
> Limit the size of your battleships and you also limit their cruising radius. Limit your cruisers.

Cut them down from 10,000 tons to 6,000 tons, and you limit their coal-carrying capacity and their range of activity. Limit the size of your submarines and you automatically limit their range of activity.

Where does this limitation make a difference? Where does it mean an advantage for Great Britain? The answer lies in two words—naval bases. England has bases at Gibraltar, Malta, in India, at Singapore, in Hongkong. In the Atlantic she has bases at Jamaica and Bermuda and in Halifax. Where has America bases like that?

Under the Washington treaty we gave up the right directly to establish a base at Guam and indirectly to increase our naval facilities in the Philippines. Cut your activity and the radius of your warships, and every time you do it you help the nation with many naval bases, and that nation, par excellence, is Great Britain.

Abolish battleships, or do away with the great monsters of the first line, and you aid Great Britain, relatively speaking. Cut the size of your cruisers so that they cannot steam so far and you aid British sea strength. Limit submarines to defensive size and you relieve the long British lines of communication from peril. It is good British policy.

England may be expected to agree that an equality be established between British and American cruiser strength. Just as there was a five-five ratio on capital ships, there should be a five-five ratio for cruisers. But—and this is important—the British will point out that they have only the cruisers they really need, and that therefore, in establishing an equality, it is their cruiser strength and not American cruiser strength which must be taken as the standard. Great Britain will agree that America should have the right to build as many cruisers as she has—if America wishes.

Skillfully enough, the British figure that President Coolidge never will wish the result of his conference to be that America embark on a program of building twenty or twenty-five modern cruisers to catch up with the English. That would be far from effecting the economy at which the American President aims. Therefore they calculate that we will be satisfied with a ratio of equality on paper and will not seek to put it into effect.

As for submarines, the British will point out that the French and Italians wish undersea boats only for defensive purposes and plan to propose that submarines be limited in size and cruising radius to prevent long-range activities. Therefore there is reason to believe that the French already are willing to accept this provision as part of the general League of Nations disarmament program.

RESULTS OF ECONOMIC CONFERENCE.—Forty-six nations, including three non-league states—United States, Turkey and Russia—were represented by slightly over 1,000 delegates in the International Economic Conference at Geneva which opened on May 4 and ended three weeks later. The six United States delegates were headed by Henry M. Robinson, former member of the Dawes Committee, and included Norman H. Davies, former Under-Secretary of State; John W. O'Leary, president of the Chamber of Commerce of the United States, and Dr. Julius Klein, director of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce. Prominent in the Soviet delegation, which arrived a day late under close protection of Swiss police, were the head of the delegation, Prince Ossinski, and the Hungarian Eugene Varga, former chief adviser of Bela Kun. The attendance of the Soviet delegation, made possible by the recent understanding with Switzerland, was regarded as significant in that, whereas Russia had rejected offers of coöperation in similar gatherings at Genoa and The Hague, she was now eager for coöperation with the capitalistic nations.

The first four days of the session were devoted to surveys of the general economic situation by heads of the chief delegations. On May 9 the conference divided into three main commissions on Commerce, Industry, and Agriculture, and these again into a great number of sub-committees. The final report adopted in the plenary session of May 23 was far too general and voluminous for detailed summary. It gave a broad survey of world, and especially European, economic conditions, pointing out that depression was chiefly felt in certain major industries, such as iron, steel, ship building and chemical products, which had been artificially stimulated by the war. Lack of capital, due to diminished savings, had prevented economic development on a pre-war scale. European tariffs were in general higher, more complicated, and more changeable than before the war, and the habit had developed of putting up excessive tariffs as a basis for subsequent bargaining with neighbor states.

The work of the Industrial Commission was devoted chiefly to the problem of international cartels or trade combinations, of which there are now seventeen in Europe, with others in process of formation, the best known being the international steel combination. Such combinations are in general favored by France and Germany, but are viewed askance by England and also by Sweden and some of the smaller states. The final report was, therefore, necessarily non-committal, pointing out advantages and disadvantages, and recommending the whole

question to the League for further study. It was stated that in certain branches of industry consolidation might systematize production, reduce costs, avoid wasteful competition, and thus assure greater stability of employment and lower prices. On the other hand, such combinations if monopolistic might check technical improvements, bring about artificial price increases, and restrict supplies of raw material or basic products in certain countries.

The American chairman of the commission, Mr. Robinson, abstained from voting on the completed report. The Soviet delegate assailed all combinations as designed "to tighten the economic dictatorship of the world."

GREAT BRITAIN

RAID ON SOVIET TRADE HEADQUARTERS IN LONDON.—On May 12 a large force of London police, acting under a magistrate's search warrant and with the authorization of the English Home Secretary, raided the five-story London office building of Arcos, Inc., the trading organization of the Russian coöperative societies. Thorough search was made of the offices of this organization and also those of the official Soviet Trade Delegation located in the same building. The special object of the search was a British secret document which was believed to have come illegitimately into the hands of the Soviet agents. Although this document was not found, a vast number of papers were seized, officials and clerks were detained and searched, two strong rooms were broken open, and the search was not completed until May 16. As subsequently stated by Premier Baldwin, the search bore out the results of previous police investigation and afforded abundant evidence that the trade headquarters had long been a sort of clearing house for communist propaganda, not only in England, but in America and the British nations overseas.

DIPLOMATIC RELATIONS SEVERED.—Following the raid, Premier Baldwin on May 24 announced in parliament a complete and final ending of the trade agreement with the Soviet government and a rupture of diplomatic relations. This, he explained, did not mean hostile measures against the Soviets, nor would any obstacle be placed in the way of legitimate trade.

The Premier's statement included definite evidence showing conclusively that Soviet agents in the building were carrying on military espionage and political propaganda directed, not only against the British Empire, but also against the United States, Mexico, and other countries. Among documents which officials attempted to burn was a long list of addresses for communication with Communist agents in the United States, Mexico, and elsewhere. A British White Paper gave detailed evidence supporting the Premier's statement.

Subsequently a resolution introduced by the Labor Party providing for a special committee of investigation before rupture of relations was defeated in the House of Commons by a vote of 367 to 118. Both Premier Baldwin's statement in Parliament and the subsequent note of Foreign Minister Chamberlain to the Russian charge declared that the Soviet government could not be disassociated from responsibility for the offenses committed. Since the sharp warning in the British note of February 28, there had been no cessation of these activities in direct violation of the Anglo-Soviet Trade Agreement.

SOVIET CURB ON TRADE ENVOYS.—On May 28, following the break with England, the Soviet government published an edict ruling that Soviet trade delegations abroad would thereafter be completely subject to the control of the Russian political representatives accredited to those nations. The Russian diplomatic envoy will be the sole political representative of the Soviet government and is justified in suspending all projects of the trade delegation not in harmony with the laws of the country in which such activities are carried on.

FRENCH PRESIDENT IN ENGLAND.—The official visit of President Doumergue and Foreign Minister Briand as guests of King George, in the latter part of May, had apparently no noteworthy political significance other than as a gesture signifying the continuance of friendly coöperation between England and France. In the conferences between Foreign Ministers Chamberlain and Briand the nearest approach to agreement related to the further evacuation of the Rhineland, which it was agreed not to consider as a present issue, pending the complete execution of Germany's pledge to de-

molish fortifications on the Polish frontier. From Germany, however, came reports that this work had already been completed by the end of May, and that renewed agitation for reduction of the French forces in the Rhineland might be expected.

ITALY AND SOUTHEASTERN EUROPE

LITTLE ENTENTE WEAKENED.—The ninth conference of the "Little Entente" powers, Rumania, Czechoslovakia, and Jugoslavia, held at Joachimsthal in the second week of May, ended in a decided weakening of the entente as a political combination. After five hours of discussion showing unanimity on scarcely a single political issue, it was at last resolved, on the initiative of Foreign Minister Mitilineu of Rumania, that the idea of political solidarity should be pigeonholed and activities centered on building up cultural, economic, and commercial union. It was found impossible for the three nations to unite in a solid front either with Jugoslavia against Italy, or with Rumania against Russia. In the past the Little Entente has in general followed the aims of France, and its weakening was taken as a blow to French schemes for maintaining Balkan unity against Italy and the Central powers.

The closest approach to unanimity of feeling among the three Balkan nations was their common suspicion of Hungary, and their worry over the recent agreements between Hungary and Italy signed during Count Bethlen's April visit to Rome. These agreements consisted of a general treaty of arbitration, no different in fact from similar treaties negotiated by Italy with Rumania and Czechoslovakia, and also a convention providing for the use of Fiume by Hungary as the chief outlet for her trade. To Jugoslavia in particular, the arbitration treaty appeared to have the effect of isolating her among nations all bound by Italy to keep the peace.

MASARYK REËLECTED.—Violating a constitutional provision which limits the president to two successive terms, the Czechoslovak parliament in joint session on May 27 by a vote of 274 out of a total of 434 reëlected Dr. Thomas G. Masaryk for the third time as President of the Republic. President Masaryk is now seventy-seven years of age and has held office since the founding of the republic in 1918.

FAR EAST

WEAKENING OF HANKOW GOVERNMENT.—During May there were many reports of large-scale military operations in China, including the northward march of General Chiang Kai-shek into Shantung, a great advance eastward of the Christian General Feng against the Northern forces, and fighting north of Hankow; but up to the end of May none of these operations had given results of clear significance.

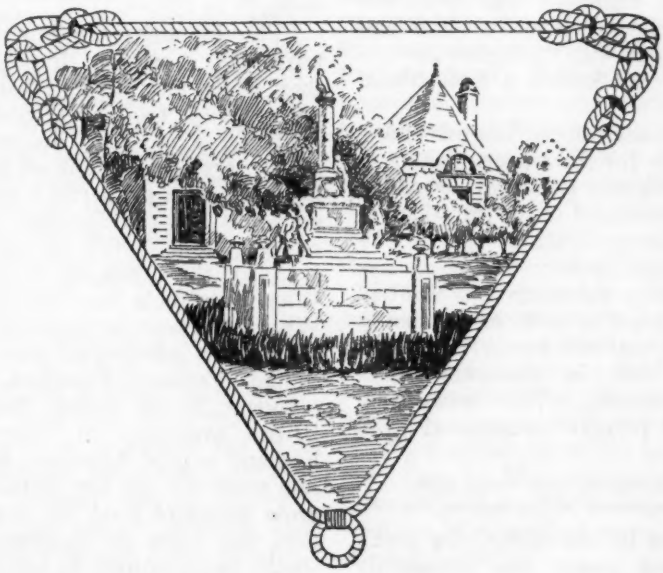
The breach between the radical nationalists and Chiang Kai-shek, though still open to compromise, had evidently weakened greatly the government at Hankow. Loss of trade and industry had brought the Hankow district to the verge of ruin. Treatment of foreigners by Chinese officials and people became much more conciliatory. On May 27 it was reported that the Soviet agent Borodin had fled southward, though Foreign Minister Chen declared his absence only temporary. At the same time Hankow was reported to be surrounded by hostile or mutinous forces, and to have sustained a severe defeat in fighting with the northern troops in Honan province.

NO REPLY TO CHEN'S NANKING NOTE.—In view of the warning of the Hankow radicals, the British government early in May came into line with the United States view that no reply to Foreign Minister Chen's unsatisfactory Nanking notes was worth making. Toward the Nanking government, British Minister Miles Lampson later in the month maintained a stiff attitude, refusing to open negotiations until definite atonement was offered for the indignities and insults inflicted upon the British at Nanking.

In view of the threatened spread of the Civil War into Shantung province, the Japanese Cabinet late in May took measures to strengthen the Japanese naval and military forces at Tsing-tau, where there is a Japanese colony of about 3,000. Strict neutrality was declared as between the warring Chinese factions, the object of the defense measures being solely to prevent the repetition of such offenses as occurred at Nanking.

FIRING ON FOREIGN VESSELS.—In spite of the friendly professions of the Nanking Government, there were continued reports of attacks on American and other foreign vessels at Nanking and elsewhere. On May 13 the U.S. Destroyers *Edsall* and *Pillsbury*, with an American merchant vessel, were fired upon from both shores at Nanking. The fire was returned by rifles and machine guns until the Chinese were silenced. No casualties were reported, though all three vessels were hit. Nanking at the end of May was still closed to foreigners, and the American consul remained off the city in a destroyer.

ANOTHER SOVIET PROTEST.—Alarmed as to the fate of Madame Borodin and the other Soviet emissaries held at Peking, the Soviet government early in May sent another note to Peking warning of the serious consequences if these political prisoners were put to death. Peking reports indicated that the prisoners were still alive, but were being kept *incommunicado*, and no date was set for their trial.



THE LIBELLE OF ENGLYSHE POLYCYE

Edited by Sir George Warner. Oxford University Press. American Branch, New York. $3.50.

REVIEWED BY CAPTAIN D. W. KNOX, U. S. NAVY (RETIRED).

The Libel of English Policy is a poem written by an unknown author in about 1436, with the purpose of demonstrating that England should give priority to developing her sea power rather than continue the then customary military efforts at conquest across the channel. The poet was evidently a person of great wisdom and vision, in close touch with the higher government officials, if not indeed a high official himself.

The poem is printed in old English and is therefore not easy for the modern person to read, but this difficulty is largely overcome by the critique contained in the introduction written by Sir George Warner.

In view of English history during the five hundred years since the poem was written, it is of great interest to note the constantly reiterated theme that sea power inherently served a dual rôle in promoting both security and prosperity. His "trewe processe of Englysh polycye" is summed up in the couplet:

> Cheryshe marchandyse, kepe thamyralte,
> That we bee maysteres of the narowe see.

As pointed out by the editor, the poet's conception of sea power was necessarily governed by the conditions of navigation and commerce in his own time, and had reference only to seas surrounding the British Isles. Nevertheless his principles and arguments are "no less applicable to altered circumstances with a far wider scope, and his wisdom and foresight have been amply confirmed" by more modern conditions of world-wide commerce.

The greater part of the poem is concerned with an extensive survey and analysis of contemporary sea-borne trade, presented in a way to show how advantageous it would be to England, both from a political and an economic viewpoint, to acquire control of the sea. At that time Flanders was a great industrial country where most of the trade of northern and western Europe centered. English wool and tin were essential raw products for Flemish manufactures, and thus an important element in the commerce with all of Europe, most of which was transported by sea and necessarily passed within a short distance of the English coast, and hence easily controllable by strong English fleets.

"The Flemings are reminded in caustic terms that it was by draping English wool they made their living, their own country not growing foodstuffs enough to support them for a month." In our own time it seems very odd to think of England as having been once primarily a producer of raw materials for the factories of another far richer country which did not grow enough food for the needs of its own population. What a miracle has sea power wrought! What a contrast between the arguments of the ancient anonymous poet, that England should dominate Flanders politically and economically by ruling the sea, and the British argument of today that because England is now dependent upon imports of raw materials for her factories and fails to grow sufficient food for her large population, her right to superiority on the sea should be recognized by her commercial and political competitors.

STATESMANSHIP OR WAR

By Brigadier General J. M. Palmer, U.S.A.

Doubleday, Page & Co., Garden City, N.Y. $2.50.

REVIEWED BY CAPTAIN D. W. KNOX, U. S. NAVY (RETIRED).

In *Statesmanship or War* General Palmer pleads for moderation of armaments as a

primary requisite of peace, pointing out that war may come in consequence of either under-preparedness, or over-preparedness, the latter being deemed especially provocative of war. He advocates an adaptation of the Swiss system of national defense to this country; an "Army of the People" being the principal element of defense. We should develop our enormous military resources "enough not to invite war, but not enough to provoke war."

His treatment of the purely military side of the question, covering about two-thirds of the book, requires little other than favorable comment on the part of the reviewer. Discussion of naval topics however is filled with fallacy and paradox, more especially in the numerous comparisons which are made between Great Britain and the United States. In this field the necessarily incompetent General appears to have been victimized by the widespread British propaganda which has been current in this country for a number of years. All the familiar arguments of the British propagandist appear in his text; even to the extent of erroneously asserting the existence of American naval propaganda, and, what is more surprising, to the extent of slurring the American naval officer, in the discharge of his duty to his country. The value of these latter means to the foreign propogandist should be obvious. Their use by an American Army officer is extraordinary and is striking evidence of the potency of the British propaganda.

General Palmer's conception of the mission of the Navy as being "an auxiliary element in the national defense" rather than the "first line," and his view that the Navy's primary rôle in warfare is the "defense of our overseas commerce and the security of our overseas communications" rather than protection against invasion, are quite in accord with long held naval thought. But he seems incapable of deducing logical conclusions from these premises, and assumes the alpha and omega of national defense to be the prevention of "invasion." Both the North and the South were invaded during our civil war. The final victory of the North was in no small measure due to her control of sea communications.

In the late war Germany was not invaded. Her resources and capacity for production and her corresponding independence of overseas imports were quite comparable with that of the United States. She was deficient in the production of but a few essential items, just as this country is. Yet the blockade was a cardinal burden to her. If Germany had controlled the seas she would without a shadow of doubt, have won the war easily. She came very near to doing so with only partial control during the short period of time when her submarine campaign was sucessful. If it is merely serious invasion that is to be provided against, the General is quite right in ascribing to sea power a very secondary place in the national armaments. But let him also avoid the paradox of failing to apply the same logic to Britain, Japan, and other countries whose principal menace must come from overseas.

In the case of Great Britain the author recognizes and emphasizes that "national defense" comprehends a defense of overseas commercial and political interests. He assumes that in equity she must needs be accorded special privilege in keeping and swelling her already great wealth and power, by being permitted control of the sea. With this superiority Britain will not harm us because not having any overseas interests of consequence, nor being entitled to them, we are secure in our "army of the people" against any possible invasion at home. On the other hand if "we should maintain a Navy strong enough to assure command of the sea" it would "certainly create suspicion and might easily lead us into temptation." Similarly with respect to Japan, we cannot be trusted with superior naval forces in the Orient (with adequate land forces in the Philippines) because "However sincere our defensive aims might be, we would instantly employ the instrument for aggression in the Far East." How extraordinary! How specious! How contradictory of historical evidence in a hundred ways! Trust everyone but ourselves!

The General considers that it would be absurd for us to develop our foreign commerce to the extent of threatening our capacity for self-subsistence. Let us agree and also point out that this danger is so remote as to constitute no reason against our participating with other nations in the lucrative profits of foreign commerce. He thinks it would be "unspeakable folly" for us to make ourselves "dependent upon naval power as a consequence of neglecting our

capacity for self-subsistence." At best this is a lame argument against our development of foreign commerce on a large scale as is now being done under the urge of profits and which it would be futile to attempt suppressing. But the strange paradox in the General's argument lies in the fact that Britain has already committed what he characterizes as "unspeakable folly," as applied to us, yet he now thinks it equitable and logical that the rest of the world should assist Britain not only in perpetuating the folly but in pyramiding it also.

The solution of Britain's problem of food supply does not lie in increasing her incomparable overseas commerce and control of the sea, as the General seems to deduce from British propaganda. Let him examine into the under-developed agriculture of the British Isles and the possibilities of further development of her great fish supply in home waters. Let him consider the geographical position of Britain, which assures her adequate food imports from North America when warring with a European country and similar imports from the Baltic and northern Europe if her enemy is overseas. In neither case is her "daily bread" critically dependent upon maintaining the world wide communications which her commercial prosperity demands. In either case a moderate Navy would prevent starvation.

Anything approaching a sea blockade of Britain would of course bring about a serious economic situation for her. The same thing can be said of the United States. Millions of wage earners would be thrown out of work and reduced to poverty. Perhaps more individuals would be thus affected in the United States by a blockade than in Great Britain. General Palmer seems to have no appreciation of the close relation between sea power and national economics, and even less understanding of naval strategy. He takes no account whatever of the naval power inherent in Britain's splendid system of bases which renders her much superior to us with an assumed parity in ships, gives her the power to blockade us in the Atlantic, and assures her of the integrity of her own principal world wide communications.

The General's outline of our naval strategy in the case of war with Great Britain, his conception of naval lines of communication on an army pattern, and his general deductions as to the naval power which we should properly have for a "respectably defensive posture" without having a "provocative" naval force, are too amateurish to warrant serious consideration. One of his fundamental assumptions is that "Ours is the only country capable of impregnable defense without making its defensive posture, in any sense, a menace to world peace." This seems to have led to a consistent advocacy of exclusively American sacrifice at every turn. One example will be sufficient to illustrate this state of mind. He thinks that we have no justification for maintaining forces adequate for the defense of the Philippines, yet that Britain has every ethical right to such forces as are required to defend India and hundreds of other colonial possessions.

Considerable space is devoted to a consideration of events leading up to the Washington Limitation Conference and to a discussion of its effects. The United States is blamed for having started the competition in naval armaments, and for having "directed against Great Britain" our 1916 construction program. Referring to the Conference Mr. Hughes is said to have first "laid down the formula (of limitation) and then called in the naval experts to work out its technical details." One would think that such errors would be guarded against in what purports to be a serious examination into the fundamentals of international relations. There is scarcely a page in the large naval section of the book but what is open to grave criticism of fact or logic. As an example of the potency of foreign propaganda the book is well worth careful study.

STEAM TURBINES. By G. Belluzo, Professor of Heat and Hydraulic Engines at the Polytechnic, Milan. Translated by Engineer Captain A. G. Bremmer, O.B.E., R.N. Charles Griffin and Company, Limited, London, J. B. Lippincott Company, Philadelphia, Pa. $17.50.

In spite of the fact that many good books dealing with the steam turbine are published in this country, it is very desirable that the works of eminent European authorities be available to our engineers. If the work is good, and if in addition it is published in our own language, the book becomes a valuable contribution to our store of available information.

The author is recognized as an authority in Italy and is well known in England. He designed the turbines for the S.S. *Oldfield* built in England, and also those of the Destroyer *Francesco Crispi.* In 1903 he became professor of hydraulic turbine construction at the Polytechnic in Milan, and in 1907 was appointed to the professorship of heat and hydraulic engines. Today he holds several important offices in technical societies in Italy, and is the present Minister for National Economy of that country.

The work consists of a volume of 732 pages, contains a great number of excellent illustrations, and is devoted principally to the design and construction of the steam turbine.

There are five principal subdivisions of the book, and in all forty-three chapters.

Part I deals with the thermodynamics of steam, particularly as it affects the steam turbine. This part is replete with diagrams and tables, and discusses the characteristics of steam, beginning with its formation from water and carrying it through the various processes. The numerous physical and thermal relations associated with it as well as its action in passing through the turbine are discussed.

It is interesting to note that in his consideration of the rapid state changes undergone by the steam in a turbine, the author does not employ the supersaturation theory which is at present so generally accepted by British engineers. He makes his analyses on the basis of ideal equilibrium conditions, as the American engineer is in the habit of doing.

The chapter which deals with the movement and flow of steam in passages with curved longitudinal sections is unusual. In it the author analyzes rather thoroughly the various phenomena of pressure changes as well as the losses that occur in relation to the centrifugal force of the steam in flowing through the passage. He shows that the heat losses vary with the velocity of the steam, the curvature and length of the passage, the thickness of the jet of steam and its specific gravity and consequently its pressure. Discussions of the results of experimental research regarding the flow of steam, particularly with reference to turbine passages, are given with some important conclusions.

Part II deals with calculations met with in practical turbine design, and very thoroughly covers every detail of the turbine.

Part III deals with the construction of steam turbines, the forms and materials of construction, and contains numerous excellent descriptions of the various elements.

Part IV deals with the application of the steam turbine to marine propulsion. The author discusses the desirable number of propeller shafts and their speed in relation to the size of the ship and the power of the propelling plant, the direct and geared turbine, the principal types of mechanical reduction gears, the cruising speed of warships with especial reference to increasing efficiency at this speed, the astern turbine, and finally the utilization of the exhaust steam from auxiliary machinery.

Part V deals with the application of the steam turbine to railway traction. The author is a pioneer in this work and gives some of the results of his own investigations. He describes some of the later European developments along this line, states some of the problems, and indicates in a general way the approach to their solution.

Throughout the book the author generally has very thoroughly discussed in a rational manner the various subjects, and makes very few statements involving calculations without first proving his assertions.

There are many references to original papers and investigations.

Although the metric system is used exclusively, the translator has included a table for the conversion of metric and English measures as well as a summary of symbols most frequently met with in this volume. Both of these aid greatly in making the conversions and in following the equations.

The translator deserves a word of favorable comment for the able manner in which he has performed his work. The text is easy to read and he apparently has faithfully carried out the author's ideas in the translation.

The reviewer's opinion is that this excellent book is a valuable addition to any modern engineering library as a reference book.

G. B.

SECRETARY'S NOTES

President Coolidge's Memorial Day Address

The President's Memorial Day address should be carefully studied by every citizen; the officers of our services who have not had an opportunity to read it should do so and those who have read it should read it again. It is not only a tribute to those who have laid down their lives for America but it is a lesson in patriotism. Many of our self-appointed historians, statesmen, diplomats, and citizen fix-its, who are continually proclaiming their own particular virtues and abilities to run every department of our government might not learn anything from the address to be sure, but it would not do them any harm—it might serve as a mirror to see themselves as others see them. They have what the editor of *The Saturday Evening Post* might call an "inferiority complex"—but this type is seldom capable of self-analysis.

He Spent Three Days at the Naval Academy Four Years Ago

"Deplores Yale Men See Angell So Little—College Paper Suggests Seniors Will Lay Eyes on President for First Time at Graduation." These were the headlines of a special dispatch to the New York *Times*, May 16.

For the information of the Yale undergraduates there was an article in the April number of the *World's Work* which among other things, stated that Dr. Angell was chairman of the Board of Visitors at the Naval Academy, Annapolis, Maryland, in the spring of 1923.

Under a New Haven date line the special to the *Times* said:

> The *Yale Daily News*, in an editorial today, suggests that the recognition which the diploma may bring will not be the greatest honor in store for the graduates at commencement, but that "the highest honor these men will have will be the novel privilege of seeing the President of Yale University. Of course, those who do not receive the sheepskin will have completed their four years without resting eyes on this personage," it says.

French Commend Dr. Butler and the Columbia Professors

"Ninety university professors, scientists, men of letters and artists of France" have commended President Butler and the forty-two members of the faculty of political science at Columbia University for their stand on the cancellation of the war debts.

In the interest of fair play it should be recalled that Dr. Hibben of Princeton and 102 of his professors also discussed this subject. Harvard has been silent; nothing has been heard from Dr. Angell.

So far as is known, Mr. Mellon has never made public the names of those Americans favoring debt cancellation who have mailed him their bonds for cancellation. It would be interesting to see a list of names of those who have made their actions speak louder than words.

Lincoln Would Not Have Been Able to Enter Present Day Civilian Colleges

"Had Abraham Lincoln been living today," Professor Whittlesey of Princeton declares "he would not have gone to college. *A mind like Lincoln's would have outrun all bounds and been unwelcome at the average university.*" The professor adds that neither would Grover Cleveland have fitted into the modern college world and that Benjamin Franklin and Thomas Jefferson would have been dismissed.

We are not competent to discuss the shortcomings of Princeton or the other civilian colleges but we might observe that this seems to be the open season for taking pot shots at the modern birds of educational training; perhaps all the gunners, the civilian as well as naval, are shooting at them on the ground and not on the wing.

The World Still Loves Frankness, Modesty and Simplicity

Lindbergh's modesty, frankness of speech, simplicity, and general behavior have drawn almost as many favorable comments as have his skill and bravery—some have gone so far as to say that the former characteristics are even more remarkable than the latter. His "we," referring to his plane and himself, has captivated an entire world. He loves his *Spirit of St. Louis* as a sailor does his ship, an infantryman his gun, and a cavalryman his horse. A good workman loves his tools.

"Perhaps few will realize," he says, "how I hate to put that ship on a boat," (referring to his proposed return from Europe to New York.) "After what it has done it seems a shame—a sort of disgrace and indignity—to have some other motive power take it home. It's a true ship of the air and rightly should travel only in the air. But unfortunately for ships, as well as for fliers, they cannot always do exactly as they please; so we are going back across the Atlantic by boat. I only hope the *Spirit of St. Louis* understands just how the other half of our pased "during the entire Atlantic flight" as he

And he got a sensation which he had misrtnership feels about the matter."

rode in an automobile from Croydon Field to London when he found the car he was in was headed directly for another, approaching head on, and when it was "twenty feet away from us I closed my eyes and shrunk down into the cushions to better stand the shock." He adds nothing happened and he opened his eyes. "No one had told me they drive on the left side of roads in England." Will Rogers has a rival when it comes to frankness and directness of speech.

Lindbergh Has Stirred the Imagination and the Emotions of the World

It seems superfluous to add to the countless hundreds of thousands of words that have been written of the heroic flight of Lindbergh and his *Spirit of St. Louis,* but according to all evidence at hand, his flight has stirred the emotions of mankind as no other event in many years. Presidents, kings, ambassadors, the press, governments, cities, and the peoples of all nations are vying with each other to do him honor. He has been proclaimed as having done more to further the good relations between the United States and France than all the diplomats and rulers have been able to do in ten years.

It is universally said that the future of the debt settlements between the two countries has been made brighter through this modest and gallant young aviator; that he has done more in thirty-three and one-half hours than has been accomplished in months by the discussions on this subject; that also he has inestimably bettered the relations between this country and Europe.

The arrival and stay of Lindbergh in Paris was one grand triumphant ovation and similar honors were paid in Belgium and England. His reception in Paris has been compared to the wildest scenes of the World War, and not unfavorably with that accorded to President Wilson upon the occasion of the latter's *first* visit to France. Lindbergh's home reception eclipsed even that of Dewey or Pershing; in fact the press reported no American has ever received such an ovation as he received in Washington and New York.

No more striking and convincing evidence can be collected to prove that man's *emotional* side is still the strongest and to point out how this young American has captured the world's imagination.

What a sorry old world this would be, too, if it were all reason and logic! Surely the sentimental, the emotional, and the spiritual sides of man are not the least important!

One spark can still kindle the greatest conflagration and human nature is still unchanged!

The Flight Itself

The Navy is second to none in voicing its praise of Lindbergh's personality, skill, and bravery, and perhaps, better than others, more fully realizes what he had to overcome and what made his flight successful.

After first joining with the public in the above recognition, the Navy is impressed with at least two features—the engineering and the navigational.

Without an engine that could stand the terrific strain put upon it no one, no matter how skilled or brave, could have succeeded.

Lindbergh had confidence in the engine selected and it did not fail him.

What perhaps is most striking of all, however, was his dead reckoning navigational ability. Enthusiastic air companions have testified he has a sixth sense, likening it to that of the homing pigeon. Be that as it may, naval officers the world over, read with sympathetic understanding Lindbergh's account of his landfall and his hail to the fishing boats asking if he "was on the right road to Ireland" and his subsequent thoughts to himself that in making up his mind "it was Ireland . . . . rather than Spain or some other country, the rest was child's play."

To naval officers his skill as a "dead reckoning" navigator was made more evident by his convincing statement "that 'we' came on the Irish coast just three miles away from where I had expected to was merely a coincidence. On the other hand, if 'we' had been 100 miles way, it would not have been a coincidence." How refreshing and how true a ring!

In addition to giving great credit to his engine the young man, who takes his honors so modestly, also pays tribute to his earth inductor compass, which so miraculously guided him on the flight.

The Navy likewise pays homage to his navigation.

The Flight of the Bellanca Plane "Columbia"

In some respects this flight although not so dramatic as that of Lindbergh's is more impressive from an engineering point of view in that the distance covered was greater and that a passenger was carried. Lindbergh made his flight alone and was solely responsible for piloting, navigating and his own self moral support.

In the *Columbia's* flight it is difficult to make comparisons between Chamberlin and Lindbergh as regards skill in piloting and navigating; the former's time in the air was eight and one-half hours greater. Encountering fog and gales upon approaching the European coast, which continued during the second night when over Germany, it required courage and skill of the highest order to continue the flight until the fuel gave out. No matter how generous Chamberlin may be in his public expressions of the assistance Le-

vine may have been to him, there is no doubt but that the former deserves the highest credit and praise.

Levine's action in accompanying him has served to silence former criticisms and shows what stuff he is made of.

These two flights emphasize three points, however, in addition to personal skill and courage, for these human qualities have never been found wanting in mankind, particularly in aviation. They are:

First, the great progress in aëronautical engineering—the aircraft motor and aircraft design;

Second, the successful introduction of aërial navigational instruments, particularly the earth inductor compass, a description of which appears below.

Perhaps a third should be mentioned, namely, the progress made in aërology or the study of meteorology and the law of storms.

Unofficial figures for the two flights show that Lindbergh's plane, weighing five thousand pounds, made one hundred and nine miles per hour and nearly nine and one-half miles to the gallon while the *Columbia,* weighing fifty-six hundred pounds, made at least ninety-three miles per hour and eight and sixty-five hundredths miles to the gallon. These figures show that the performance of the two hundred horsepower Wright Whirlwind air-cooled engine, the same single type of motor used in each plane, was approximately the same in each flight, making due allowances for differences in rates of flying speed and weight carried, whether computed on the basis of speed per hour per pound, or fuel consumption per pound per mile. These calculations of course are rough checks as there are no reliable data at this writing.

The Earth Inductor Compass

So far as is known Lindbergh did not drop any smoke bombs by day nor torches by night, to determine his drift. So far as is known no use was made of the drift indicator. Despite a reported "wind on the tail," the feat of keeping his plane on its course, with no one to keep track of his "dead reckoning" but himself, with the necessity not only to handle the controls but to determine whatever drift there was, and unaided except by his eye and the "feel," are in themselves subjects of admiration.

The inductor compass is quite unlike either the magnetic or the gyroscopic compass. It was first tried out practically about five years ago and has been steadily developed since then. Commander Byrd had one in the Arctic, both in 1925 and on his polar flight in 1926, although on the latter trip he depended mostly on the Bumstead sun compass.

The inductor compass is manufactured by the Pioneer Instrument Company of New York and a description of it, given below, is from the chapter on Aërial Navigation, from Commander Dutton's *Navigation and Nautical Astronomy,* published by the Naval Institute:

> The inductor compass operates upon the principle of an electric generator. It consists of a small armature rotated either by an electric motor or by a wind fan. [In Lindbergh's flight the wind fan was driven by the air as his plane sped through it]. The magnetic field is furnished by the horizontal component of the earth's field. The brushes can be rotated around the commutator by means of a controller which carries a dial graduated in degrees. A lubber's line on this dial indicates the course set on the compass. When the plane is flying on the course set on the indicator, the brushes are on the magnetic east and west points of the commutator and no current flows in the line to the indicator. This indicator is merely a sensitive voltmeter. To use the compass, the navigator merely sets the course desired on the controller dial and the pilot maneuvers the plane until the indicator shows zero. Because of the variation in strength of the horizontal component of the earth's field, this compass

does not indicate how many degrees the pilot is off course at any instant, but it does indicate in which direction he is off the course. The main advantage of this compass lies in the fact that the generator element can be mounted in the tail of the plane or any other spot where magnetic conditions are favorable, while the indicator can be mounted before the pilot's eyes.

Nungesser and Coli

The initiative and valor of the French could not have been better exemplified than by the action of her two intrepid sons setting out so fearlessly across the western ocean in the Paris-New York flight.

In paying homage to others upon whom Dame Fortune was kinder, the world has not forgotten and joins with sorrowing France in both admiration and sympathy.

Commander Pinedo's Hard Luck

The Navy has watched the Italian naval officer's four-continent flight with greatest interest and admiration. Despite all obstacles, and there have been many, his fighting spirit, seamanship, navigation, and airmanship have excited much favorable comment.

It was from Trepassey Harbor, Newfoundland, that our own three *NC* seaplanes departed for the Azores just eight years ago, and they encountered much the same kind of weather as did Pinedo on nearing the Islands.

The Secretary was on station that morning in one of the destroyers marking the line of flight, some 150 miles west of Corvo, and had the thrill of seeing at dawn in mid-Atlantic all three *NC* planes in flight. The weather was fine, sea calm, with every indication of continued good weather. In less than six hours a local gale appeared in the islands and two of the *NC* boats were down, while the *NC-4* found her way into Horta.

It seems the irony of Fate that Pinedo should have encountered similar weather and on this leg of his voyage, which appeared so little formidable, when compared with his flights across the South Atlantic and across the Brazilian wilderness.

As was expected of him he flew back to the point where forced down and then flew to Lisbon and from the latter point back home to Rome.

Deaths in Peace and War

"The pen is mightier than the sword," but as an instrument of destruction rather than of peace, the latter has been displaced by the automobile. According to press dispatches of May 13 over 3,000,000 American citizens have been sent to the hospitals as a result of motor car accidents in the past five years and during the same period over 100,000 have been killed, one-third being children!

There are 30,000 graves of American soldiers being decorated today (Memorial Day) in France, and yet over three times that number of our citizens have been killed in peace in the past five years, and a hundred times that number have been sent to hospitals.

Sometimes it is difficult to see the forest on account of the trees.

Paraphrasing a Popular Slogan

An attempt has been made not only to obtain the best available grade of paper for the illustrations for the benefit of our readers, but also for our advertisers. To the best of our knowledge no magazine published today has a grade or quality of paper superior to the cream ivory heavy coated enamel paper now used. To paraphrase a popular slogan, "When better paper is used, the PROCEEDINGS will use it."

"The Art of Flying" by Lieutenant Studley

Lieutenant Studley, the author of an article appearing in this issue, has just completed a three years' tour of duty as a flight instructor at the Naval Air Station, Pensacola, and he stresses the point that naval aviators are born not made—that "flying is an art"— while an *aviation officer* can be made. The article should be interesting to all officers who

contemplate going to Pensacola for the course, as well as to all who are adding to their knowledge of naval aviation.

Prior to going to Pensacola and within two years after graduation, the young officer is given twenty-five additional hours instruction in the air either at Hampton Roads or San Diego, ten hours of which is dual instruction at the controls and he may be allowed to solo. This is in addition to his Naval Academy course in aviation and aëronautics.

It is hoped there may be "Discussion" of the author's paper as there are several points upon which service opinion as a whole differs. One such point appears to be the natural aptitude of the candidate for flying honors.

In "Causes of Aviation Accidents," will be found a concise, interesting statement regarding accidents by William D. Tipton, staff aviator of the Baltimore *Evening Sun* from his column "With the Flyers." Major Tipton commands a crack aviation unit in the Maryland National Guard, is an expert flyer, and saw service in the Army Air Forces in France during the World War.

Other authoritative statements have been made that ninety-five per cent of all aviation accidents occur within 500 feet of the surface and that of these ninety per cent are due to faults of personnel. Henry Ford not long ago said that ninety-five per cent of flying today was personnel, and five per cent mechanical (meaning depending upon engine and construction), whereas the figures should be reversed before there would be "flivvers of the air." In this he seems to be more or less supported by Lieutenant Studley.

Causes of Aviation Accidents

Those who have read Lieutenant Studley's article appearing in this issue entitled "Flight Training of Student Naval Aviators," (see page 764) will be interested in the following clear cut account by Major W. D. Tipton in the Baltimore *Evening Sun* of May 10, 1927:

The recent string of fatal accidents in naval aviation—ten in the last thirteen days—has revived the old cry of unsafe aircraft for the services. [He could have added military accidents as this goes to press, May 30.]

The ten deaths resulted from four crashes; four in the *F-5L* seaplane, which was apparently struck by lightning; two in an *N-9* training seaplane; two in an *M-B2* training seaplane and two in the Keystone *Pathfinder*. It is true that eight of these deaths resulted from accidents to obsolete aircraft. However, it must be pointed out that obsolete does not mean unsafe.

The *F-5L* is a huge, obsolete, twin-engined flying boat. It recently had been rebuilt by the Naval Aircraft factory at Philadelphia, and so far as humanly possible was in good flying condition. The supposition that it was struck by lightning removes obsolescence or unfitness for flight from the situation. The *N-9* training plane is decidedly obsolete, being of war-time design, and its use for training purposes should have been discontinued long ago. The Boeing *M-B2* training plane was three years old and is of a type since discarded by the Navy. The Keystone *Pathfinder* was a modern airplane, brand new, and this crash resulted from overloading in experimental tests to determine its ability to lift fuel necessary to make the New York to Paris flight.

The public may be easily misled on the subject of old aircraft. An airplane may be ten years old, based on the date of original construction, and yet by careful repair and overhaul it may in spite of its years be perfectly safe so far as its constructional integrity is concerned. However, the fact is never made clear that in spite of constructional safety, the more modern the airplane the safer it is aërodynamically.

What "Stall" Means in Flyer's Parlance.—Fully 75 per cent of the fatal accidents may be attributed to the pilot's loss of control of his craft in flight, usually following a stall. This term "stall" is always misconstrued when used in news statements of accidents and a simple explanation is due. An airplane requires a certain speed through the air in order to sustain itself and obtain the necessary reactions on its control surfaces to obtain control of the craft in flight.

The average speed for flight and control is about forty-five miles per hour. When the speed of

the airplane becomes less than flying speed, the airplane in old designs quickly, and in new designs slowly, stalls and drops into a nose dive which must be continued for about 200 feet before the speed of the plane is increased above the stalling speed, whereupon control is regained and the plane pulled out of its dive.

The fundamental aërodynamic difference between obsolete and modern designs lies in the manner in which they stall and allow of regained control after a stall. The old design when stalled will quickly drop into the dive, often falling off to the side, whereupon it drops into a spin. Furthermore, these old designs require more altitude for recovery after a stall or spin. Consequently if an old design is stalled at an altitude of less than 500 feet from the ground a crash is almost sure to result.

In modern aircraft when slowed down either by too steep a climb or too flat a glide without power, the stall occurs gradually and the airplane gives warning of the stall point by gently dropping its nose in spite of efforts of the careless pilot to pull it up, thus increasing the stall. Even after the plane has stalled it will not drop quickly into a spin, and even if it does it is very easily recovered. It thus is seen that a careless or green pilot may do many more foolish things with a modern airplane than he can with an obsolete design with comparative safety.

Plane Compared With Automobile.—An airplane may be compared in some sense to an automobile climbing a hill. Certain hills are not too steep for the car to mount without appreciable loss of speed. On others the car gradually slows down until it can proceed no longer in high. So with the airplane. It can climb an aërial hill of so much slope without loss of speed to the danger point. When climbed too steeply its speed continues to drop until the danger point is reached, and while a good pilot can sense this point long before danger is present, many pilots do not have the "feel" of the plane to recognize the point. Here lies the difference between natural pilots who fly by instinct and those who fly mechanically.

So in criticizing the services for using old aircraft one should always bear in mind the fact that these airplanes are in good flying condition, as good, in fact, as the day they were built. There are few, if any, records of accidents where in normal flight an airplane in the service failed for structural reasons. As a matter of fact, it would be criminal negligence for a commanding officer to allow airplanes to fly in questionable mechanical condition, and such action would lead swiftly to court-martial.

The public must become accustomed to the fact that as long as airplanes fly there will be fatal crashes just as there are fatal wrecks in railroading, disasters at sea and fatal collisions in motoring. It is a fact that as years pass the percentage of accidents is slowly decreasing. In army aviation the fatalities a few years ago were 4 per cent of those engaged in flying; now they are less than 2 per cent.

Commercial Flying Not so Hard Hit.—Modern design is seeking every means to make flying safer and is really accomplishing something. Commercial flying, where the pilot is picked for his ability and conservativeness does not suffer as do the services. The columns of the press seldom chronicle a death in regulated and well organized commercial operation in spite of the fact that commercial air lines make a veritable network over this continent. In the services, however, conditions are different. Flying by pilots of all states in training is done, and no one will deny that the student pilot flying solo in his first hundred hours is the highest risk of all.

Should all obsolete aircraft, either service or civil, be eliminated, safety in flying would greatly increase. To make this possible in the services is a job for Congress in greater appropriations or for the heads of the services in summarily eliminating such craft and greatly curtailing flying. The records of the army's flying school show that when the obsolete training plane was replaced by the present standard with its steel fuselage, which resists the tendency to crumble after crashes, and greater control, the fatal accident rate dropped quickly almost to the vanishing point. Modern aircraft unquestionably will bring greater safety, and it is in aërodynamic design, attributable to an increase in design knowledge, and not to more careful maintenance, that we must look.

The Outside Loop Is Finally Made

Lieutenant J. A. Doolittle, U. S. Air Service, winner of the Schneider Cup Race in Baltimore, 1925, accomplished the outside loop on May 25, at McCook Field, Dayton, Ohio. According to an Associated Press despatch the event was described as follows:

Flying over Dayton yesterday at an altitude of 8,000 feet, Lieutenant Doolittle turned the nose of his plane downward and described a huge circle, 2,000 feet in diameter, and returned to level out at his original height. The flyer was on the "outside of the circle" throughout and was held in his seat only by straps. At the lowest point of the circle he was directly under the plane, flying at a speed of

280 miles an hour. As he climbed back the speed of the ship was retarded to the approximate 150 miles an hour he was making when he went into the loop.

When Lieutenant Doolittle landed his eyes were bloodshot and he gave evidence otherwise of the severe strain of the feat. Today, however, he declared he had suffered no ill effects.

Doolittle used an HB-1 Curtiss pursuit plane with a regulation Curtiss D-12 engine of 420 horsepower. He flew with a specially constructed safety belt strapped about him, the usual safety belt being deemed insufficient to afford protection against the extreme pull at the bottom of the loop.

Fourth Air Record Broken by Naval Aviator in Four Weeks

The Washington *Star* of May 22 describes the new speed record for seaplanes made by Lieutenant Rutledge Irvine in the following language:

A new world speed record for seaplanes is claimed by the Navy for Lieutenant Rutledge Irvine, who was credited yesterday with a speed of 130.93 miles an hour for 1,000 kilometers over the inclosed triangular course.

Smashing the previous record of 103.372 miles an hour made by the Italian flyer, A. Pasaleva, Lieutenant Irvine flew over the course in four hours and forty-four minutes, thereby hanging up the fourth world record broken by naval aviators during the past few weeks.

Irvine made the flight in a Navy Vought Corsair observation plane, equipped with the Pratt & Whitney 500-horsepower Wasp air-cooled engine, the same type of machine used by the Navy in establishing its other records. Carl Schorey, representative of the National Aëronautic Association, was the official observer for the flight.

The naval airman took off at 12:46 P.M. with a terrific burst of speed. It was soon apparent that he was far exceeding the speed of the former record holder. The A.A.A. announced later that the records are being forwarded to France for confirmation.

Lieutenant Irvine is thirty-one years old, having been born in Brooklyn on July 7, 1896. He was a student at Cornell University, enrolled in the Naval Reserve in 1917, and was commissioned an ensign and qualified aviator August 13, 1918. He is now attached to the naval air station at Anacostia, D.C.

This is not the first time that Lieutenant Irvine has attracted public attention by his flying, for he was a member of the Navy team participating in the Schneider International Trophy race at Cowes, England, in 1923, finishing second in that race.

Naval officials were jubilant over the fourth world record broken by their airmen in as many weeks. April 14 Lieutenant George R. Henderson established an altitude record for seaplanes of 22,178 feet. Lieutenant S. W. Callaway on April 23, carrying a load of 1,102 pounds, established a speed record of 147.263 miles an hour for 100 kilometers, and on April 30 Lieutenant J. D. Barner made a speed record of 136.023 miles per hour for the 500-kilometer distance.

Graduation at the Naval Academy

The Class of 1927 which graduated June 2 had the distinction of having the largest class ever graduating from the Naval Academy, there being a total of 568 members.

This class donated a sum of $5,000 for a stained glass memorial window to go in the Chapel and the donation has been accepted by the authorities.

In the baccalaureate sermon Chaplain Evans said, among other things, addressing his remarks directly to the class:

Our country knows that every graduate of this Academy is a man symmetrically trained, and expects him to be generally and particularly competent; ready for efficient service. Your diploma is a guarantee that you have attained at least a certain proficiency in navigation and seamanship, mathematics, ordnance, engineering and aëronautics, English and modern languages.

But it is quite conceivable that this proficiency might have been attained at schools other than this. The diplomas stand for something so far greater, that in the sight of God and the unseen cloud of witnesses who have preceded you, all these other acquirements without it would weigh little indeed.

Your Alma Mater has endeavored, while developing and equipping your body, mind and spirit, to mould in you a character which shall have certain very definite marks. Her ideal is that what you

are is vastly more important than what you have, that qualities and habits are far more important than material possessions, integrity than position, self respect than popular applause. The real Naval Academy is invisible, a thing of the Spirit, with its ideals and traditions of Truth, Honor, Duty, Loyalty, Courage, Initiative, Chivalry, and Self-sacrifice.

Remember that the voice of duty is God's voice for you, and always, "underneath are the everlasting arms." Let the acceptance of your commission mean a definite act of self-dedication and surrender in your inmost soul of all you are or ever hope to be to God and His will for you. If you always are true to God you will always be true to your country, your shop, your men, your family, yourself, and He is your only sure guarantee. And as you leave the Academy, your home port in your naval career, and begin your life cruise as leaders of men, I would give to each one of you in the name of your Alma Mater, the points of your compass, Truth, Honor, Self-control and Courage; your horizon, Loyalty; your chart, the character, principles and deeds of Him who is still the Ruler of wind and waves; your north star, your conscience; your sailing directions, love and service of God and love and service of your fellow men. With this fixed in your inmost being—your Alma Mater will have no undue anxiety. She knows that the ship of your soul, come storms upon it from without or from within, motivated by the great, spiritual dynamo of the Universe, will keep steady on its course across the sea of life and across the the sea of death and make its port. And, she will have a pride in her son's glorious reward of a "well-done" from our Commander-in-Chief.

Retiring Member of Board of Control and Assistant Editor of "Proceedings"

Due to receipt of orders to sea duty, Commander R. A. Theobald, U.S.N., and Lieutenant Commander C. H. McMorris, U.S.N., have resigned, respectively, as a member of the Board of Control and as assistant editor of the PROCEEDINGS. Captain C. E. Smith, U.S.N., has been appointed vice Theobald, and Lieutenant Felix L. Johnson, vice McMorris.

Naval Institute to Publish Lieutenant Commander Weems' "Line of Position" Book

The Naval Institute will publish the book on Navigation entitled *Line of Position,* by Lieutenant Commander P. V. H. Weems, U.S.N.

The book is based on the methods described in his article in the May PROCEEDINGS. Its contents will be restricted to the tables and explanations necessary for the solution of the line of position under all conditions. For an explanation of the mathematics involved and for other details of the method, reference should be made to the article.

The book will be bound in a flexible leatherette water-proof binding, its dimensions to be approximately those of the *Nautical Almanac,* so that it will fit the coat pocket. A separate additional large size azimuth diagram, mounted on a folding cardboard, will be printed for those who do not work in constricted spaces.

The contents of the *Line of Position* book will be:

PAGE	SUBJECT
1	Time to arc conversion table and star altitude correction table.
2	Sun altitude correction table.
3- 4	Moon altitude correction table.
5- 7	Explanation of tables and typical problems.
8-34	Altitude tables.
35-36	Left portion of azimuth diagram.
37-38	Right portion of azimuth diagram.
39-40	Aviator's Speed-Time-Distance table, and course correction table.

For all latitudes up to 65 degrees, this handy book of forty-four pages, together with the *Nautical Almanac,* will provide *all data necessary for the working of lines of position under all conditions.*

Price $2.50 postpaid; for separate large size azimuth diagram, 80 cents.

Financial Assistance to Naval Historical Foundation Voted by Naval Institute Membership

The regular membership of the Naval Institute has voiced its approval of the proposition recently voted upon to contribute to the Naval Historical Foundation the interest on $10,000 at five per cent per annum for a period of five years from April 1, 1927.

The Third Year of Aviation and Aeronautics at the Naval Academy

It will be recalled that the subjects of Aviation and Aëronautics were added to the Naval Academy curriculum in 1925 and those not completed during the regular four-year course are completed by the class remaining at the Academy during the summer immediately following graduation.

Few realize that the Academy is the largest aëronautical school in the world today so far as the study of the elements of these subjects, are concerned.

In order to present a clear understanding of the basis of the Naval Academy course of instruction in aviation the following comments have been made by the Superintendent:

It is not a course to qualify aviators. It is a course to give graduates as a whole an understanding of the fundamentals of aviation as a part of the general naval education. No attempt is made, or intended, to qualify any individual as an aviator any more than the making of an ensign the navigator of a battleship because he has had a course in navigation. The aviation course at Annapolis bears similar relation to a general service foundation as do the courses in gunnery, engineering, navigation, etc. There is included in the academic course certain theoretical work in connection with the fundamentals of aviation both from the point of view of material and operation, but this is only preparatory in the same way that trigonometry is preparatory to astronomy and navigation.

The course consists of the following subjects and number of hours in each with an additional hour of study preparatory to every hour of recitation: aviation history, three hours; theory of flight, eight hours; structure and rigging, twenty hours; aviation engines, thirty-four hours; radio instruments, twenty hours; aircraft communications, three hours; aërology, eight hours; navigational instruments, three hours; aërial navigation, twenty-six hours; aërial gunnery, sixteen hours; aërial bombing, ten hours; range gunnery, twenty-four hours; scouting, twenty-seven hours; practical work in the air in observer's duties respectively as mechanic, gunner, radioman and navigator, two and one-half hours each. There is radio code practice and the student officer must learn "procedure" and spend enough time on this subject to receive code at the rate of eighteen words per minute.

In the class last summer there were ninety-three per cent out of 293 who met the above standards in radio.

Summer Course, 1925

The first summer course was established in accordance with the preceding basic orders and began June 7 and ended August 31, 1925; one hundred and fifty-two midshipmen of the class of 1926 successfully completed the course remaining at the Naval Academy while the remainder of the class went on the regular practice cruise.

The 1925 summer course was practically the same as that prescribed for the "Ground School Course" and for "Ground Gunnery" at the Naval Air Station, Pensacola, Florida, the text books being the so-called Pensacola (Aviation) Manuals. Pensacola methods were used and Pensacola graduates were in immediate charge of the instruction, marking, etc.

The flight instruction was given in planes of the H-16 and F-5L types. An aircraft division from the Aircraft Squadrons, Scouting Fleet temporarily based at the Naval Academy, had charge of this instruction.

The class visited Philadelphia for a two days' inspection of the aircraft factory.

Twelve lectures were given on general aviation subjects.

Summer Course, 1926

During the academic year, 1925-1926, aviation subjects were added to the four year curriculum for the second and first classes. Such subjects as were necessary to complete the theoretical "Ground School Course" were included in Part I of the summer course which began June 6 and ended June 26.

The remainder of the class of 1926 took the summer course, 1926, as ensigns and second lieutenants (Marine Corps) approximately 276 ensigns and twenty-one second lieutenants, a total of 297.

Part I of the course was intensive theoretical work and Part II, June 28 to August 14, was largely practical supplementing the theoretical.

Radio code practice and radio procedure was conducted throughout Parts I and II.

The course also consisted of a visit to the aircraft factory, Philadelphia, one-half of the class going at a time for two and one-half days' visit; a prescribed reading course assignment, together with approximately twelve lectures, were assigned for night periods during Part II.

An aircraft squadron (from the Scouting Fleet) of twelve seaplanes similar in type to the planes here last year was available for this year's flight instruction.

Summer Course, 1927

In order to cover the very large size of the present class, which is practically double in excess of the resources of the Naval Academy for this particular form of training, the ground-work has been practically absorbed into the academic year, leaving the summer available for actual flying, engine testing, gunnery, navigation, etc. The class has been divided into two parts, one part to be given a five weeks' course after graduation, the other part to go on leave, at the close of which the first part on leave is to return and the second part to be granted leave before reporting to their ships.

Approximately one-half of the present first class commissioned as ensigns and second lieutenants, Marine Corps (262) reported June 10, and the course will end Friday, July 15; the second half of the class (approximately 262) will report not later than Saturday, July 16, and the second course will end Friday, August 19.

Non-receipt of "Proceedings" in the Mail

The membership is requested to keep the Institute informed of any change in address, and every effort will be made to have the corrections made on our mailing list. It is realized that officers making so many changes in stations will find that mistakes will occur. It is a curious thing that, while the Secretary himself has never failed during the past twenty-five years to receive his copy of the PROCEEDINGS promptly, he has been unable, while in Annapolis, to receive through the mails regularly a prominent New York newspaper. Despite every effort made and numerous letters written, no satisfactory service could be given, and the newspaper had to be discontinued.

Membership

New members not previously published:

Adams, R. P.
Appel, E. S.
Alexander, M. W.
Armstrong, H. F.
Allen, I. R.
Allen, A. M.
Bieberbach, M. W.
Beckwith, J. A.
Barber, Courtney
Brown, J. F.
Boillorgeon, J. C.
Brown, A. M.
Baker, F. C.
Bernrieder, W. A., Ens. U.S.N.R.
Belmont, E. A.
Carmichael, John
Cushman, J. S.
Callery, William
Chesbrough, W. J.
Carlstedt, G. C., Lieut. U.S.C.G.
Cowie, G. D.
Carr, H. C.
Curtis, J. H.
Devlin, F. R.
Dana, Duncan
Dunning, M. O.
Drake, A. C.
Dyke, H. G.
Edel, A. F.
Ewald, J. B., Lieut. Comdr. (SC) U.S.N.
Elms, F. M.
Flather, A. C.
Fisher, J. H.
Fraher, J. E., Lieut. U.S.N.R.
Farmer, Z. J.
Foster, H. G.
Fickett, F. W., Sr.
Gibson, H. D.
Gherardi, Bancroft
Gilbreth, L. M., Mrs.
Glidden, E. G.
Goodridge, J. W.

Greathead, J. F.
Hickman, M. R.
Harris, T. S.
Hansen, Omar
Howard, O. W.
Horne, R. F.
Hook, E. W.
Hansen, P. A.
Haines, R. M.
Heinrici, H. E.
Harding, G. F.
Jackman, J. C.
Kelly, Clyde, Captain U.S.N.R.
Leutze, E. H., Rear Admiral U.S.N. (Ret.)
Lively, M. R.
MacMullin, F. J.
Macauley, Alvan
McKee, J. D.
Miller, R. B.
McCullock, F. D.
Morgan, J. P.
Norton, H. K.
Newman, L. B.
Newberry, Barnes
Nickerson, C. M.
Newhart, H. G., Midn. U.S.N.
Nelson, F. V.
Probst, E. E.
Penseyres, G. W.
Phleger, Herman
Powell, L. R.
Pillsbury, E. B.
Parr, H. L.
Quotidomine, Francis, Ch. Gun. U.S.N.
Rice, H. G.
Rockwood, G. I.
Roberts, J. A.
Rodman, Hugh, Rear Admiral U.S.N. (Ret.)
Roemer, C. G., Lieut. Comdr. U.S.C.G.
Rogers, Nicholas
Rose, R. E., Jr., Ens. U.S.N.
Rue, F. J.
Ryerson, E. L.
Ramsey, J. C.
Robinson, B. R.
Roundtree, John, Lieut. U.S.C.G.
Robison, Walter
Rich, A. R.
Riley, G. D.
Sadler, H. C.
Schnell, F. H., Lieut. Comdr. U.S.N.R.
Schott, G. F.
Schumm, H. C.
Scrivenor, Arthur
Scott, A. B.
Scott, F. A.
Scott, P. H., Comdr. U.S.C.G.
Scott, W. L.
Scully, D. B.
Seaman, Van Brunt
Seeds, E. L.
Seymour, A. D.
Shearer, J. H.
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Smith, A. M.
Smith, F. A., Mrs.
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Southgate, H. M.
Stanton, S. C.
Stearns, G. A. M., Mrs.
Steers, Henry
Stevens, C. B., Midn. U.S.N.
Savage, C. C.
Smith, D. C.
Shapleigh, A. L.
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Sams, A. F., Jr.
Stika, J. E., Lieut. Comdr. U.S.C.G.
Stout, H. F., Ens. U.S.N.
Storer, J. H.
Strong, H. C.
Stuart, W. H.
Sylvester, J. M.
Talbot, Richmond
Taylor, G. M.
Taylor, G. P.
Thompson, R. E.
Tod, R. E.
Tout, Wilson
Townsend, S. D.
Traiser, R. E.
Trebes, John, Lieut. Comdr. U.S.C.G.
Trecartin, D. M.
Trefethen, D. B.
Trumpy, John
Tubbs, A. S.
Tweedy, J. H., Jr.
Tucker, L. B.
Tracy, W. W.
Trowbridge, E. P.
Van Wyke, W. P.
Van Leer, W. M.
Van Vleck, H. R.
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Vaughan, G. W.
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Wallace, F. W.
Wilson, C. A.
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White, Miles, Jr.
Wilder, L. R.
Wordell, A. H., Lieut. U.S.N.R.
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Wadbrook, W. P. E., Lieut. U.S.N.
Wales, L. B.
Wallace, D. B., Ens. U.S.N.R.
Watson, H. L.
Weaver, C. W.
Weaver, G. C., Ens. U.S.N.
West, C. C.
White, R. W.
White, William
Whitsel, T. S.
Wolcott, Oliver
Woods, F. L.
Wood, J. M.
Woodcock, A. W. W.
Wrenn, P. G., Lieut. U.S.N.
Yale, W. T.
Yeandle, S. S., Lieut. Comdr. U.S.C.G.
Young, A. W.
Zimmerman, W. F.

PUBLICATIONS

U. S. NAVAL INSTITUTE

STRATEGY AND TACTICS

The Dardanelles Expedition. Second Edition, 1927.

By Captain W. D. Puleston, U.S.N. A critical study of this amphibious undertaking. 70 illustrations. Semi-flexible red Buckram Binding. $2.80 postpaid. ($2.25 to officers of the U.S. Army, Navy, Marine Corps, and Coast Guard, to members of the Institute, to all U.S. government departments, and to all who saw service in the Dardanelles Campaign.)

Five Years in Turkey.

By General Liman Von Sanders, Chief of the German Military Mission to Turkey. Translation by Colonel Carl Reichmann, U.S. Army (Retired). Off the press about 1 July, 1927. 340 pages, illustrations and three military maps. Price $3.50 postpaid.

NAVAL LEADERSHIP

Naval Leadership: with Some Hints to Junior Officers and Others. 2nd Edition, revised 1925.

Containing some 200 pages of clear type on good paper, in a neat and durable fabrikoid binding, in a size convenient for the pocket, approximately 4½x7⅛". $1.50 postpaid.

NAVAL ORDNANCE

Exterior Ballistics, 1926.

A new book for the instruction of midshipmen. By Lieutenant E. E. Herrmann, U.S. Navy, under the direction of the Head of Department of Ordnance and Gunnery. This book supersedes Groundwork of Practical Naval Gunnery, or Exterior Ballistics 1915. 322 pages with tables and figures. $6.00 postpaid.

Range and Ballistic Tables, 1926.

Prepared for use of midshipmen as an auxiliary companion volume for Exterior Ballistics, and contains tables which are required with the latter textbook. $4.70 postpaid.

Naval Ordnance, 1925.

A textbook prepared for the use of Midshipmen by Officers of the United States Naval Academy. Revised and brought up to date. 641 pages, illustrated. $8.00 postpaid.

LAW

International Law for Naval Officers.

Brought up to date and a new chapter on "Angary" added. By Comdr. C. C. Soule, U.S. Navy, and Lieut. Comdr. C. McCauley, U.S. Navy. 153 pages. Revised, 1925. $2.00 postpaid.

Constitutional Law. Reprinted 1924 with slight additions.

By H. J. Fenton, M.A., LL.D. 351 pages. $2.25 postpaid. This book was recently used as a textbook at the U.S. Military Academy, West Point.

ELECTRICAL ENGINEERING

Robison's Manual of Radio Telegraphy and Telephony.

This is the 7th revised edition of this book. By Commander S. C. Hooper, U.S. Navy. 737 pages, illustrated. 1927. Price $5.50 postpaid.

Radio Manual. A Textbook for Midshipmen.

First Revised Edition. Prepared for the Department of Electrical Engineering and Physics, Naval Academy. This book is a revision of the 1925 edition, and contains 40 per cent more material. $3.50 postpaid.

Naval Electrician's Textbook, 1922.

Vol. I. Theoretical, 640 pages, illustrated. $4.80 postpaid (corrected and reprinted 1925). Vol. II. Practical, 473 pages, illustrated. $3.00 postpaid.

Storage Battery Manual, Including Principles of Storage Battery Construction and Design, 1920.

By Lieut. Comdr. Lucius C. Dunn, U.S. Navy. 400 pages, illustrated. $2.00 postpaid, formerly $7.00.

NAVAL CONSTRUCTION

Principles of Naval Architecture and Warship Construction.

By Lieut. Comdr. G. C. Manning (CC), U.S. Navy, and Lieut. T. L. Schumacher (CC), U.S. Navy. A treatise especially prepared to furnish in compact form the information required by the operating personnel of the U.S. Navy. 1924. 368 pages, with many illustrations and drawings. $5.00 postpaid.

Naval Artificer's Manual, 1918.

By Lieut. McCall Pate (CC), U.S. Navy, 797 pages, illustrated. $2.00 postpaid.

NAVIGATION

Aquino's "Newest" Sea and Air Navigation Tables.

Off the press about 1 July, 1927. By Commander Radler de Aquino, B.N. Price $5.00 postpaid.

Navigation and Nautical Astronomy.

By Commander Benjamin Dutton, U.S. Navy. It is a thorough treatise on the subject, and is the standard textbook for instruction of Midshipmen. 1926. $5.50 postpaid.

Navigation and Compass Deviation, 1918.

By Comdr. W. C. P. Muir, U.S. Navy. 765 pages. $4.20 postpaid.

Practical Manual of the Compass, 1921.

By Captain Harris Laning, U.S. Navy, and Lieut. Comdr. H. D. McGuire, U.S. Navy. 234 pages, illustrated, $3.90 postpaid.

Line of Position Book.

By Lieutenant Commander P. V. H. Weems, U. S. Navy. Off the press about 15 July 1927. 44 pages approximately. Also separate large azimuth diagram. $2.50 postpaid. Diagram $.80 postpaid. (For full description see page 832, this issue).

MARINE ENGINEERING

Principles of the Basic Mechanisms.

Prepared for use of midshipmen by Lieut. Comdr. R. N. S. Baker (CC), U.S. Navy, and W. E. Farrell, Associate Professor, U.S.N.A. 1926. 132 pages, $3.75 postpaid.

Engineering Materials and Processes.

Prepared as a text book for midshipmen. Is the successor to Danforth's Mechanical Processes. By Lieut. Comdrs. G. B. Ashe, and J. I. Hale, (CC), U.S. Navy. 1926. $3.90 postpaid.

Internal Combustion Engines.

Their Principles and Applications to Automobile, Aircraft, and Marine Purposes.

A complete and thorough revision of the 1920 edition by the Department of Marine Engineering and Naval Construction, U.S. Naval Academy.

Obsolete material has been omitted, and much new material has been added, such as Diesel engines, aircraft engines and naval type-V engine. 1925. 266 pages. $3.40 postpaid.

Naval Reciprocating Engines and Auxiliary Machinery, 1922.

By Commanders J. K. Barton, U.S. Navy, and H. O. Stickney, U.S. Navy. 634 pages, illustrated, with Atlas containing 48 plates. $6.50 postpaid.

Marine and Naval Boilers, 1920.

By Lieut. Commanders Frank Lyon, U.S. Navy, and A. W. Hinds, U.S. Navy. 404 pages, illustrated, $3.80 postpaid.

Naval Turbines, 1924.

By Commanders O. L. Cox, U.S. Navy, and M. A. Libbey, U.S. Navy. Prepared primarily for use in the instruction of midshipmen, the book covers the latest principles involved in turbine design and construction. 251 pages with many illustrations and drawings. Price $5.00 postpaid.

MATHEMATICS

Engineering Mathematics.

Prepared for the Department of Mathematics for instruction of midshipmen. It is a revision of the 1925 edition and contains about 30 per cent more material. 1926. $2.70 postpaid.

Elementary Mechanics.

A complete revision of the 1922 edition, by Professor Paul Capron and Associate Professor L. T. Wilson, U.S.N.A. 1926. 189 pages. $5.00 postpaid.

PHYSICAL TRAINING

Manual of Athletic Requirements.

By Department of Physical Training, U.S. Naval Academy. Now under revision—will be ready about 1 July, 1927. Approximate price $4.00.

LANGUAGES

Writing and Speaking: a Handbook for Naval Officers.

By Professor Carroll S. Alden, U.S.N.A. (This book is to replace "Composition for Naval Officers.") Just off the press. 359 pages. $2.50 postpaid.

French Nautical Phrase Book and Reader.

By Professor P. J. des Garennes, U.S.N.A. 1921. 181 pages. $1.50 postpaid.

A Spanish Nautical Phrase Book and Reader.

Reprinted 1925 with additional corrections. By Professor Arturo Fernandez, U.S.N.A. 175 pages. $2.00 postpaid.

AVIATION

Naval Aviation.

A textbook primarily for the instruction of midshipmen, but is valuable to the service at large. Everything of a technical nature has been purposely excluded. Compiled by Lieut. W. W. Warlick, U.S. Navy. 128 pages. $1.75 postpaid. Second printing, February, 1926.

Airplanes, Airships, and Aircraft Engines, 1921.

By Lieut. Albert Tucker (CC), U.S. Navy. 448 pages, illustrated. $3.50 postpaid.

MISCELLANEOUS

Man-of-War's Man's Manual.

By Rear Admiral R. R. Belknap, U.S.N. (Retired). Off the press about 1 July, 1927. 225 pages. (Illustrated). Price $.65 postpaid.

Yankee Mining Squadron, 1920.

By Captain R. R. Belknap, U.S. Navy. 110 pages, illustrated. Price reduced to $1.00 postpaid.

Routine Book, 1918.

By Captain R. R. Belknap, U.S. Navy. 308 pages. Price reduced to $1.25 postpaid.

Index to Proceedings (Nos. 1 to 100) and (Nos. 101 to 200).

$.50 each, postpaid.

U. S. Navy Cook Book, 1920.

By School for Cooks and Bakers. U.S. Naval Training Station. Newport, Rhode Island. 130 pages. $.60 postpaid.

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